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Storm Water Management Model Study

Volume III

Research Report No. 62

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Research Program for the Abatement of Municipal Pollution under Provisions of the Canada-Ontario Agreement on Great Lakes Water Quality

CANADA-ONTARIO AGREEMENT

RESEARCH REPORTS

These RESEARCH REPORTS describe the results of investigations funded under the Research Program for the Abatement of Municipal Pollution within the provisions of the Canada-Ontario Agreement on Great Lakes Water Quality. They provide a central source of information on the studies carried out in this program through in-house projects by both Fisheries and Environment Canada, and the Ontario Ministry of Environment, and contracts with municipalities, research institutions and industrial organizations.

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STORM WATER MANAGEMENT MODEL STUDY

VOLUME III

User's Manual

by

Proctor and Redfern Limited
and
James F. MacLaren Limited
Toronto, Ontario, Canada

RESEARCH PROGRAM FOR THE ABATEMENT
OF MUNICIPAL POLLUTION WITHIN THE
PROVISIONS OF THE CANADA-ONTARIO
AGREEMENT ON GREAT LAKES WATER QUALITY

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This report has been reviewed by the Technical Committee of the Canada-Ontario Agreement on Great Lakes Water Quality and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of either the Ontario Ministry of the Environment, or Fisheries and Environment Canada, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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ABSTRACT

This volume, Volume III of a three-volume report, is the User's Manual for the Canadian Storm Water Management Model developed for Fisheries and Environment Canada and the Ontario Ministry of the Environment.

This Canadian study has expanded the capabilities of the original SWMM (U.S. Environmental Protection Agency). Methods of aggregating the properties of individual subcatchments into a single equivalent catchment are described. These can lead to a considerable reduction in data preparation and computer processing time. A generalized quality model was developed, based on SWMM equations and using the simplification obtained in the aggregating techniques. Snowmelt quantity and quality models have been integrated with the SWMM. Methods of interfacing the SWMM and STORM (U.S. Army Corps of Engineers) models have been discussed and demonstrated, and a fully operational package of models, capable of simulation of all aspects of storm water flow and quality, has been prepared for application to Canadian conditions.

User information on the setup and operation of the entire model, as well as setup and use of the individual program blocks, is presented in this manual. Reference is made to the U.S. Environmental Protection Agency User's Manual, where necessary, to avoid duplication.

RÉSUMÉ

Le présent volume, le dernier d'une série de trois, est un manuel d'utilisation de la version canadienne du Storm Water Management Model (SWMM), mise au point pour Pêches et Environnement Canada et le ministère ontarien de l'environnement.

La présente étude canadienne a permis d'accroître le potentiel du modèle original SWMM de l'Environmental Protection Agency des Etats-Unis. Le rapport indique comment rassembler les propriétés d'un certain nombre de sous-collecteurs en un seul collecteur équivalent. Cette méthode pourrait réduire considérablement le temps nécessaire à la préparation et au traitement des données. Un modèle qualitatif général a été mis au point à partir des équations du SWMM et grâce aux simplifications fournies par les techniques de rassemblement. Des modèles quantitatifs et qualitatifs des eaux de fonte ont pu s'intégrer au SWMM. On a examiné et décrit certaines méthodes permettant de relier le SWMM et le modèle STORM (U.S. Army Corps of Engineers). Par ailleurs, on a préparé un ensemble de modèles entièrement fonctionnels, particulièrement adaptés au milieu canadien et qui peuvent simuler tous les aspects de l'écoulement et de la qualité des eaux pluviales.

Le présent volume renseigne les utilisateurs sur l'organisation et l'exploitation de modèle ainsi que des divers blocs de programmes. Pour éviter les redites, le manuel renvoie parfois le lecteur un User's Manual de l'Environmental Protection Agency des É.-U.

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1. INTRODUCTION TO THE CANADIAN VERSION OF SWMM

1.1 Introduction

The Canadian version of the Storm Water Management Model is the result of a joint study undertaken by the firms of Proctor and Redfern Limited and James F. MacLaren Limited, sponsored by Fisheries and Environment Canada and the Ontario Ministry of the Environment under the Canada-Ontario Agreement on Great Lakes Water Quality. The changes and modifications made to the SWMM in this study created the need for additional documentation to enable users to employ the Canadian SWMM. This User's Manual constitutes Volume III of the documents prepared under the terms of the SWMM study. It is based upon the U.S. Environmental Protection Agency User's Manual - Version II [1], and certain portions of the Canadian manual were duplicated from the EPA Manual, with the kind permission of the U.S. Environmental Protection Agency. This was done where there were no changes or modifications made to the basic SWMM routines.

It was intended that the Canadian User's Manual would be useful to Canadian modellers in two ways:

1) For an inexperienced modeller, the Canadian version and EPA Version II manuals would be used together. The EPA Version II manual would provide additional information on parameters, calibration, set-up and use of those portions of the SWMM in which no changes were made.

2) Once a user has become familiar with the SWMM theory and application, then the Canadian User's Manual would provide enough information to run the model on a day-to-day basis. This would obviate the necessity of having to refer to two separate documents at all times.

A brief review of the terms of reference for the overall SWMM study, and the structure of the report is contained in the following sections.

1.2 Terms of Reference and Major Activities

Based on consideration of the state-of-the-art in 1974, the Storm and Combined Sewers Subcommittee prepared detailed terms of

reference and specified the objectives of this study. These objectives were grouped into four major areas, as follows:

1) to review and modify the U.S. Environmental Protection Agency Storm Water Management Model (SWMM) for Canadian conditions;

2) to select and modify a submodel for the simulation of quantity and quality of runoff resulting from snowmelt;

3) to develope or modify a data analysis submodel capable of extracting the meteorological input from existing data banks;

4) to select and modify a high speed model for simulation of frequency of discharges and overflows, with the capability of using output from the Data Analysis submodel as input.

1.3 Structure of Report

The report is divided into three volumes, as follows:

Volume I - Final Report*
Volume II - Technical Background**
Volume III - User's Manual

Volume I gives a description of test applications, sensitivity analyses for existing SWMM routines, suggested modifications and simplifications, and a description of new programs. A technical reader will no doubt wish to read all of the volume. A general reader should be able to obtain a good appreciation of the study by reading only the Summary, Basic Concepts (Chapter 1) and the Conclusions and Recommendations (Chapter 13). The Final Report is, for convenience, divided into five parts:

1) Introduction
2) Application of the SWMM on Canadian Watersheds
3) Modifications to the SWMM and Auxiliary Routines
4) Interfacing the SWMM with Continuous Simulation Models
5) General Conclusions and Recommendations.

---

* Canada-Ontario Agreement Research Report No. 47
** Canada-Ontario Agreement Research Report No. 48

Volume II describes previous research and reviews critically the state-of-the-art for the benefit of more technically oriented readers. The seven sections are as follows:

1) Comparative Analysis of Routing Models
2) Comparative Analysis of Water Quality Models
3) Literature Survey - Urban Runoff Quality
4) Literature Survey - Snowmelt Quantity
5) Literature Survey - Snowmelt Quality
6) Data Collection - Study Areas
7) Treatment Processes.

Volume III is the User's Manual for the Canadian version of SWMM, and also for the Data Analysis Program, the Generalized Water Quality Model, and the STORM Model. These models were applied and tested in this study and are discussed in Volume I.

Computer tapes containing SWMM, the Data Analysis Program, the Generalized Runoff Quality Model, and STORM are available from the Water Resources Branch of the Ontario Ministry of Environment. A blank tape order sheet is provided in Appendix E of this volume.

1.4 Acknowledgements

This study was sponsored by the Storm and Combined Sewers Sub-committee within the framework of the Canada-Ontario Agreement. The Sub-committee members were:

Dr. R. Slater	-	Co-chairman
Mr. G. Mills	-	Co-chairman
Mr. J. Marsalek	-	Project Officer
Mr. T. Koplyay	-	Member
Mr. D. Weatherbe	-	Member
Mr. H. Torno	-	Advisor
Dr. C. Howard	-	Adivsor
Dr. D. Waller	-	Adivsor

These gentlemen participated in many meetings and several read the drafts of this report. Their guidance and comments were both stimulating and helpful.

The team responsible for this study comprised personnel from Proctor and Redfern Limited (P&R), and James F. Maclaren Limited (JFM). The key members and their roles were as follows:

Mr. P. Hertzberg	(P&R)	-	Project Manager
Mr. P. Wisner	(JFM)	-	Technical Coordinator
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Mr. A. Brodie	(JFM)	-	Assistant Project Manager
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Dr. N. Zaghloul	(JFM)	-	
Mr. L. Pataky	(P&R)	-	
Mr. M. Ahmad	(JFM)	-	
Mr. P. Dick	(P&R)	-	

Several other staff members provided special inputs or assisted in preparation of data.

Dorsch Consult also participated in the team and was responsible for Dorsch HVM simulations presented in the report. The assistance of Mr. F. Nevius was appreciated in this regard.

Water Resources Engineers kindly made the latest variation of the WRE Model available to the team. The cooperation of Dr. R. Shubinski, Vice-President of WRE, is gratefully acknowledged.

The team greatly benefited from discussions with, and assistance from, several individuals and consultants as follows:

Prof. S. Solomon	-	University of Waterloo
Prof. G. Ganczarczyk	-	University of Toronto
Prof. E. Watt	-	Queen's University
Mr. C. Kitchen	-	City of Toronto Public Works Dept.
Mr. G. Burns	-	City of Winnipeg
Mr. L. Roesner	-	Water Resources Engineers Inc.
Mr. J. Peters	-	U.S. Corps of Engineers

Mr. J. Abbot	-	U.S. Corps of Engineers
Dr. W. Huber	-	University of Florida
Dr. J. Heaney	-	University of Florida

The team sincerely acknowledges the contribution made by all of the above-named personnel and also that made by many others, too numerous to list.

1.5 References

1. Huber, W.C., et al, "Storm Water Management Model User's Manual - Version II", Environmental Protection Technology Series, Document EPA-670/2-75-017, National Environmental Research Centre, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268, March 1975.

2. INITIAL JOB SET-UP

2.1 Computer System Requirements

The Storm Water Management Model can be run on a machine having core storage capacity of at least 350K bytes (or equivalent) and using overlay structures. In addition, the program uses peripheral storage devices which may consist of disc, tape, or drum units, depending on the machine configuration.

2.2 Program Compilation and Execution Time and Cost

A sample of typical execution times with run costs for separate program blocks is shown in Table 1. These costs include the savings which were made by storing compiled blocks of the program in a permanent job library (Load Modules). At most computer installations, there is a daily or monthly charge for storing Load Modules. If the SWMM is to be used more than a few times per month, it would be advisable to use Load Modules.

From the CPU and Execution times in this table, a time and cost estimate can be arrived at for different machines by a systems analyst.

2.3 Job Control Language (JCL)

The assignment of logical units requires, in general, the provision for files to be written on specific physical devices. To accomplish this, the user must supply the necessary JCL. As a rule, JCL is highly machine dependent; in fact, it often differs on two identical machines at different installations. Therefore the SWMM cannot include JCL that is universally applicable. The following remarks, however, may be useful in gaining an insight into what is involved on systems such as an IBM 370/168.

It is convenient on these machines to use disc storage devices rather than tape units because of the inherently faster reading and writing speed of the former. At most installations, the logical unit corresponding to the card reader is given the number 5 and the line printer is given the number 6. The Storm Water Management Model is programmed on the assumption that units 5 and 6 are so used. Typically,

TABLE I. TYPICAL SIMULATION COSTS

DESCRIPTION OF COMPUTER RUN	No. of Sub-catchments	No. of Manholes and Conduits	No. of Time Steps	Computer Processing Time (min.)	Cost of Run
1) SWMM RUNOFF + TRANSPORT, Quantity	45	159	40	1.153	$13.11
2) SWMM RUNOFF + TRANSPORT, Quantity and Quality	27	82	80	.924	$ 9.57
3) SWMM RUNOFF + TRANSPORT, Quantity and Quality	41	130	80	1.285	$19.21
4) SWMM RUNOFF + TRANSPORT + STORAGE/ TREATMENT Quantity and Quality	41	130	80	1.172	$23.18
5) SWMM RUNOFF + TRANSPORT + STORAGE/ TREATMENT + RECEIVING Quantity and Quality	41	130	80	2.826	$63.84

the system programmers have provided the necessary JCL for these units and also for the card punch (usually given the logical unit number of 7). Moreover, JCL may have been provided for scratch units, in which case the unit assignments for scratch files can take advantage of the existing JCL.

Usually, however, the data file and scratch assignments require JCL to be supplied for each unit. The rules for such JCL must be ascertained from the system's programmers, since there is considerable variation in unit number availability. In general, one should only set up the units needed in a given run, since there may be a charge for file space that is reserved, even if it is not used.

Table 2 shows sample JCL, overlay and preliminary input data to run the SWMM from a tape. Many users may prefer to store a compiled version on a disc rather than run from cards or tape. This example is for an IBM 370/168.

The following is a description of Table 2.

Line "1" is the job card unique to Proctor & Redfern.

Lines "2-3" are for execution and overlay of the SWMM source program.

Lines "4-13" describe the files on the source tape called MASTER. Example: LABEL = 2 stands for the RUNOFF Block on the tape.

Lines "14-39" describe the overlay of each block of the SWMM used.

Lines "40-46" describe scratch disc files for use in running the SWMM. These could alternatively be set up as permanent files if the same input or output is to be used for another run, for example. The following is an example of a tape or disc unit number:
//GO.FXXF001 DD... where XX stands for the symbolic unit number.

Line "47" tells the computer that input data follows.

Line "48" provides the tape/disc assignments which correspond to card group 1 of the EXECUTIVE Block Card Data Section.

Line "48" may be interpreted as follows:

JIN(1)	JOUT(1)	JIN(2)	JOUT(2)	JIN(3)	JOUT(3)	JIN(4)	JOUT(4)
0	9	9	10	10	9	9	10

Here JIN(N) = 1 refers to an input device or file and JOUT(N) = 1 refers to an output device or file. For example, a typical read statement in a FORTRAN program may be READ(1,80). The 1 is replaced by the symbolic unit number of an input device (e.g., card reader). On most computer systems, 1 is equal to 5 for reading cards and 6 or 7 for writing or punching output. The same applies for JIN(N) = 1 or JOUT(N) = 1 where 1 is substituted with the symbolic unit number of an input or output device such as a tape or disc unit, as defined by lines "45-46". Since the numbers 5, 6, and 7 have standard meanings, their descriptions are omitted.

JIN(1) = unit number of the tape/disc input into the first block to be run (RUNOFF Block). JIN(1) = 0 means there is no tape/disc input.

JOUT(1) = unit number of the tape/disc output from the first block to be run (RUNOFF Block). JOUT(1) = 9 means there is such output to be saved and line "45" describes the disc utilized.

JIN(2) = unit number of the tape/disc input to the second block to be run (TRANSPORT Block). (This is normally the same as the output number from the preceding block.) JIN(2) = 9 means there is such input (from the RUNOFF Block) and line "45" describes the disc utilized.

JOUT(2) = unit number of the tape/disc output from the second block to be run (TRANSPORT Block). JOUT(2) = 10 means there is such output to be saved and line "46" describes the disc utilized.

JIN(3) = unit number of the tape/disc input to the third block to be run (STORAGE/TREATMENT Block). (This is normally the same as the output unit number from the preceding block.) JIN(3) = 10 means there is such input (from the TRANSPORT Block) and line "46" describes the disc utilized.

JOUT(3) = unit number of the tape/disc output from the third block to be run (STORAGE/TREATMENT Block). JOUT(3) = 9 means there is such output to be saved and line "45" describes the disc utilized. (Note that RUNOFF output will be written over.)

TABLE 2. SAMPLE OF JCL REQUIRED TO RUN SWMM ON AN IBM 370/168

```
0001  //SWMM    JOB     (PR930),PERKS
0002  // EXEC F4HCLM, PARM.FORT='SIZE=350K,NOSOURCE,NOMAP',
0003  //    PARM.LKED='LIST,MAP,OVLY'
0004  //FORT.SYSIN DD UNIT=TAPE9,VOL=SER=MASTER,DSN=MAIN,DISP=(OLD,PASS),
0005  //    LABEL=1
0006  //           DD UNIT=TAPE9,VOL=SER=MASTER,DSN=RUNOFF,DISP=(OLD,PASS),
0007  //    LABEL=2
0008  //           DD UNIT=TAPE9,VOL=SER=MASTER,DSN=TRANSPRT,DISP=(OLD,PASS),
0009  //    LABEL=3
0010  //           DD UNIT=TAPE9,VOL=SER=MASTER,DSN=STORAGE,DISP=(OLD,PASS),
0011  //    LABEL=4
0012  //           DD UNIT=TAPE9,VOL=SER=MASTER,DSN=RECEIVE,DISP=(OLD,PASS),
0013  //    LABEL=5
0014  //LKED.SYSIN DD *
0015        OVERLAY ALPHA
0016        INSERT  GPLOT,GRAPH,COMBIN
0017        OVERLAY ALPHA
0018       INSERT  ABLK,ERSON,QSHEDI,GQUAL,RECAP
0019      INSERT  RUNOFF,GUTTER,HCURVE,HYDRO,RHYDRO,WSHED
0020      INSERT   INABLK,SMELT,RSNOW,SDATA
0021        OVERLAY ALPHA
0022       INSERT  TIME,CONTR,MAN,ST1,ST2,CDEPTH,INQLPQ,TRI
0023      INSERT RECEIV,SWFLOW,PRTOUT,XTIME
0024     OVERLAY BETA
0025      INSERT MANING,INDATA,TIDCF,TRIAN,SWQUAL,INQUAL,LOOPQL,QPRINT
0026     OVERLAY BETA
0027      INSERT PLOT,OUTPUT
0028        OVERLAY ALPHA
0029       INSERT  TRANS,NAMES,TABLES,PSI,FIRST,DRWF,PSIDPS
0030     OVERLAY BETA
0031       INSERT  PRINT,XX
0032     OVERLAY BETA
0033      INSERT         DEPTH,CPSI,DWLOAD,FILTH,FINDA,INFIL,INITAL
0034      INSERT  NEWTON,QUAL,RADH,ROUTE,SLOP,VEL,TSTRDT,TSTORG
0035      INSERT  TSTCST,TPLUGS,TINTRP,ACOS
0036        OVERLAY ALPHA
0037      INSERT  BLK1,BLK2,BLK3,TBLK,HIGH,STBK,VOR
0038      INSERT  STORAG,TRTDAT,INTERP,STRDAT,TREAT,BYPASS,TRLINK,SEDIM
0039      INSERT  HIGHRF,KILL,STRAGE,PLUGS,TRCHEK,SPRINT,TRCOST
0040  //GO.FT01F001 DD UNIT=SYSDA,SPACE=(CYL,(2,1))
0041  //GO.FT02F001 DD UNIT=SYSDA,SPACE=(CYL,(2,1))
0042  //GO.FT03F001 DD UNIT=SYSDA,SPACE=(CYL,(2,1))
0043  //GO.FT04F001 DD UNIT=SYSDA,SPACE=(CYL,(2,1))
0044  //GO.FT08F001 DD UNIT=SYSDA,SPACE=(CYL,(2,1))
0045  //GO.FT09F001 DD UNIT=SYSDA,SPACE=(CYL,(2,1))
0046  //GO.FT10F001 DD UNIT=SYSDA,SPACE=(CYL,(2,1))
0047  //GO.SYSIN DD *
0048     0   9   9  10   10  9   9  10
0049     1   2   3   4    8
0050   RUNOFF
```

TABLE 2. (CONT'D)

```
0051        .
0052     (DATA FOR RUNOFF BLOCK)
0053        .
0054        .
0055   TRANSPORT
0056        .
0057     (DATA FOR TRANSPORT BLOCK)
0058        .
0059        .
0060   STORAGE
0061        .
0062     (DATA FOR STORAGE/TREATMENT BLOCK)
0063        .
0064        .
0065   RECEIVING
0066        .
0067     (DATA FOR RECEIVING WATER BLOCK)
0068        .
0069        .
0070   ENDPROGRAM
0071   /*
```

JIN(4) = unit number of the tape/disc input to the fourth block to be run (RECEIVING Block). (This is normally the same as the output unit number from the preceding block) and line "45" describes the disc utilized.

JOUT(4) = unit number of the tape/disc output from the fourth block to be run (RECEIVING Block). JOUT(4) = 10 means there is such output and line "46" describes the disc utilized. (Note that TRANSPORT output will be written over.)

JIN(5) to JIN(10) and JOUT(5) to JOUT(10) allow more than just four blocks to be run sequentially and are defined similarly if required.

Line "49" provides the scratch tape/disc assignments which correspond to card group 2 of the EXECUTIVE Block Card Data Section. Line "49" may be interpreted as follows:

NSCRAT(1), NSCRAT(2), NSCRAT(3), NSCRAT(4), NSCRAT(5)

1 2 3 4 8

Here NSCRAT(N) = I refers to an input/output device or file. I is substituted with the symbolic unit number of an input/output sevice such as a tape or disc unit defined in lines "40-44". There should be a scratch tape/disc assignment for NSCRAT(1) through NSCRAT(5). Most blocks to not use all NSCRT(1) tape/disc assignments.

Lines "50-70" represent the various blocks within the SWMM model to be executed along with their corresponding data.

2.4 Overlay Procedures

In computers with small core capacity, the technique of overlaying is most important. It reduces the machine core storage which is necessary to run the model.

In Table 2, Lines "15-39" describe the overlay of each block of the model in a form which will require 350K, but it can be broken down even further.

2.5 Dummy Subroutines

If only a few of the program blocks are to be used, compilation time and cost can be saved by removing the unused blocks and replacing them with a dummy subroutine. The dummy subroutine contains only the first subroutine statement, a stop statement, and an end statement. On some

machines, such as the IBM 370/168, the use of dummy subroutines may be avoided by using the "LET" feature in the Linkage Editor, which permits the Load Module to be prepared even though unreferenced external subroutines exist.

2.6 Data Sets

Data sets for the SWMM are used to transfer information from one program block to another, or to store and transfer information between subroutines. They are usually magnetic tapes or disc storage devices. The information on them is erased after the simulation is over. The unit numbers assigned to the various data sets are arbitrary. Any desired values compatible with the descriptions of Lines "40-46" in Table 2 could be used. Furthermore, in Table 2 it is assumed that RUNOFF, TRANSPORT, STORAGE/TREATMENT and RECEIVING are to be run in order. However, various sequences may be used. Permanent data sets should be used only when the output from a block is to be saved for later runs. The JCL for set-up of these data sets is not included because of the differences in computer systems.

3. EXECUTIVE BLOCK

3.1 Block Description

The EXECUTIVE Block performs three functions:

1) assignment of logical units and files;
2) control of the computational blocks; and
3) graphing of data files by line printer.

No computations, as such, are performed. A flow chart of the SWMM, illustrating the role of the EXECUTIVE Block, is shown in Figure 1.

3.2 Program Operation

The EXECUTIVE Block assigns logical units and files, and controls the computational block to be executed. These functions depend on reading in a few data cards which must be supplied according to the needs of a given computer run.

3.3 Instructions for Data Preparation

The instructions for data preparation are divided into two parts corresponding to the assignment of the tapes and discs required for the run and the selection of the individual Blocks. Figure 2 and Tables 3 and 4 indicate the procedure for data card preparation and list the variables used.

3.4 Block Selection

The program controls the computational blocks to be executed by reading the alphanumeric information, CNAME, on control cards. Thus, for example, CNAME might be RUNOFF. The program compares this word with a dictionary of such words. If a match is found, as it would be in this case, control is passed to the appropriate block. Here, for example, the RUNOFF Block would be called. After execution of the RUNOFF Block, control would be returned to the EXECUTIVE Block.

The program again reads a control data card, which might indicate that another block is to be executed. For example, if TRANSPORT Block is to be executed the control word TRANSPORT would be given, etc. If results are to be graphed, the control word GRAPH would be on the

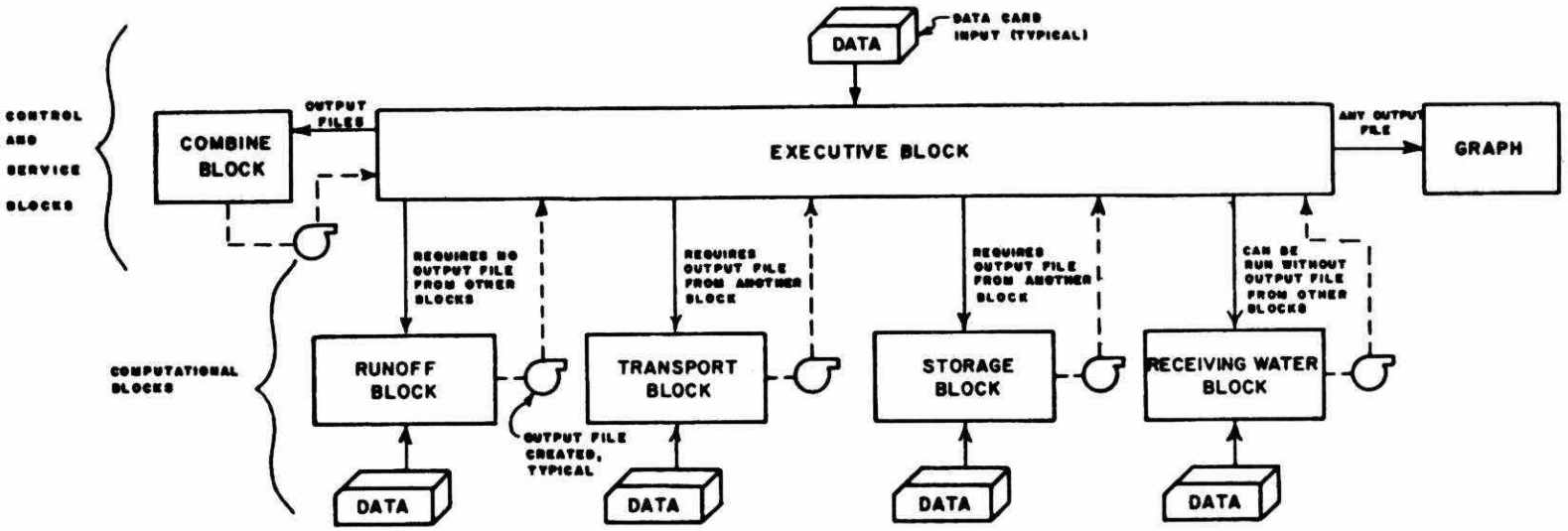

FIGURE 1. MASTER PROGRAMMING ROUTINE

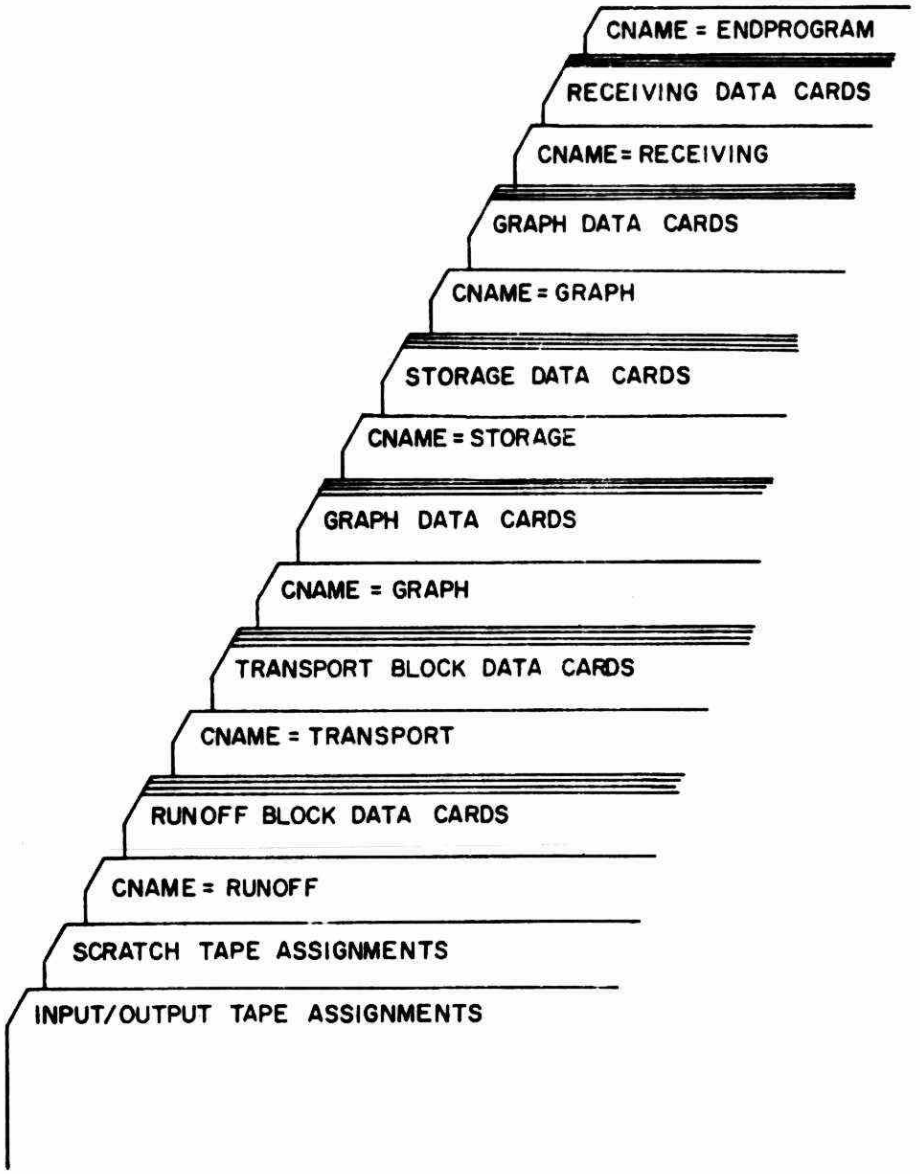

FIGURE 2. DATA DECK FOR THE EXECUTIVE BLOCK

control card, or, if the run is to be terminated, the word ENDPROGRAM is given on the card. A summary of the control words and corresponding action is given in Table 5.

The use of control cards allows considerable flexibility in use of the Storm Water Management Model. The most common type of run involves execution of one of the computational blocks along with the graphing of results on the line printer. Thus, for the RUNOFF Block, such a run would be made by appropriate use of the words RUNOFF, GRAPH, and ENDPROGRAM. If the entire model were to be run with graphical output at the end of, say for example, the TRANSPORT and STORAGE Blocks, the sequence would be RUNOFF, TRANSPORT, GRAPH, STORAGE, GRAPH, RECEIVING and ENDPROGRAM.

It is important for the user to realize therefore, that each block may be run separately. In fact, the majority of applications to date consist of a RUNOFF and TRANSPORT simulation only.

3.5 Graph Routine

The data cards required for graphing are minimal. The first card supplies control information, such as on which tape/disc the hydrographs and pollutographs are stored, the number of curves per graph, and number of pollutants. The specific plots required are designated on the next card. The last three cards supply a title for each curve, a horizontal axis label, and a vertical axis label. The vertical axis label card is repeated for each pollutant to be plotted and for the hydrograph in the order in which they are to be printed out.

TABLE 3. EXECUTIVE BLOCK CARD DATA

Card group	Format	Card columns	Description	Variable name	Default value
1			I/O tape/disk assignments.		
	20I4	1-4	Input tape assignment for first block to be run.	JIN(1)	0
		5-8	Output tape assignment for first block to be run.	JOUT(1)	0
		9-12	Input tape assignment for second block to be run (usually the same as the output tape from first block).	JIN(2)	0
		13-16	Output tape for second block to be run.	JOUT(2)	0
		.		.	
		.		.	
		.		.	
		.		.	
		77-80	Output tape for tenth block to be run.	JOUT(10)	0
2			Scratch tape-disk assignments.		
	5I4	1-4	First scratch tape assignment.	NSCRAT(1)	0
		5-8	Second scratch tape assignment.	NSCRAT(2)	0
		9-12	Third scratch tape assignment.	NSCRAT(3)	0
		13-16	Fourth scratch tape assignment.	NSCRAT(4)	0
		17-20	Fifth scratch tape assignment.	NSCRAT(5)	0
			REPEAT CARD 6 FOR EACH BLOCK TO BE CALLED.		
3			Control cards indicating which blocks in the program are to be called.		
	3A4	1-12	Name of block to be called.[a]	CNAME	None

[a]Names must start in column 1. All blocks may be called more than once if overlay is not used or if overlay is used one or more blocks may be repeated if overlay is set up for this. See Section 2, Initial Job Set-Up.

NOTE: All non-decimal numbers must be right-adjusted.

TABLE 3. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
			CNAME = RUNOFF for Runoff Block, = TRANSPORT for Transport Block, = RECEIVING for Receiving Water Block = STORAGE for Storage Block, = COMBINE for Combine Block, = GRAPH for GRAPH subroutine, = ENDPROGRAM for ending the storm water simulation.		
			INSERT THESE CARDS AFTER EACH CNAME = GRAPH IN CARD GROUP 3.		
4			Control card.		
	4I5	1-5	Tape/disk (logical unit) assignment where graph information is stored.	NTAPE	None
		6-10	Number of curves of a graph. (maximum = 5)[a]	NPCV	5
		11-15	Number of pollutants to be plotted.	NQP	0
		16-20	Number of inlets to be plotted. (If NPLOT = 0 plots all curves on file)	NPLOT	0
			IF NPLOT = 0 DELETE THIS CARD.		
5			Inlet selection card.		
	16I5	1-5	First inlet number to be plotted.	IPLOT(1)	None
		6-10	Second inlet number to be plotted.	IPLOT(2)	None
		.		.	
		.		.	
		.		.	
		.		.	
		.	Last inlet number to be plotted.	IPLOT(NPLOT)	None

[a]This refers to the number of different inlets (curves) that will be plotted on one graph; e.g. if NPCV = 3, hydrographs, say, from three inlets will be overlayed on one graph

TABLE 3. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
6			Title card.		
	18A4	1-72	Title printed with the plots.	TITL	None
7			Horizontal axis label.		
	20A4	1-80	Horizontal axis label.	HRIZ	None
			REPEAT NQP + 1 TIMES.		
8			Vertical axis label.[a]		
	2A4	1-8	Line 1 of vertical axis label.	VERT(1)	None
		9-16	Line 2 of vertical axis label.	VERT(2)	None
	3A4	17-28	Line 3 of vemtical axis label.	VERT(3)	None

[a]The first plot to be printed is a flow hydrograph, the second is BOD, the third is SS, and the last is coliform.

TABLE 4. EXECUTIVE BLOCK VARIABLES[a]

Variable Name	C*	Description	Unit
A		The log base 10 of the range of values of y coordinate to be plotted (subroutine CURVE)	
ACRES		Number of acres of study drainage basin	acres
ADDWF		Average DWF	cfs
AXA		X-coordinate of value previously plotted	
AXB		X-coordinate of value to be plotted	
AYA		Y-coordinate of value previously plotted	
AYB		Y-coordinate of value to be plotted	
CURVE		Name of subroutine	
CNAME	C	Computational block name read from data cards	
DESFLO		Design flow rate (of main trunk)	cfs
DUMMY	C	Dummy location to fill data record	
FRANG		Expanded range (even intervals) of y coordinates of curve to be plotted	
GRAPH		Name of subroutine	
HORIZ	C	Horizontal label of curve	
I		The Block selection counter (MAIN)	
IC		Calling sequence control parameter	
ILAB		Output label with plot	
INCNT	C	Array of input logical data file number	
IOUTCT	C	Array of output logical data file number	
IPLOT	C	Array of nodes to be plotted	
ITAB	C	Array indicating which locations of the data file are to be plotted	
IX		Dummy variable	
IXA		Integer value of AXA	
IXB		Integer value of AXB	
IY		Dummy variable	
IYA		Integer value of AYA	
IYB		Integer value of AYB	
J		Subscript counter	
JJ		Subscript counter	
JIN		Array of input disk/tape units	
JOUT	C	Array of output disk/tape units	
K		Subscript counter	
L		Subscript counter	
LX		Transfer location from data file to plot storage	

[a]Does not include variables added during updating.

*Variable names shared in common blocks.

TABLE 4. (CONT'D)

Variable Name	C*	Description	Unit
M		Subscript counter	
MC		Do loop counter	
MM		Subscript counter	
N		Subscript counter	
NCT		Number of plots	
NCURVE		Number of curves to be plotted	
NCV		Number of curves/plot	
NDESYR		Frequency of design flow	yr
NLP		Number of types of plot (hydrographs and pollutographs)	
NLOC	C	Node number of hydrograph point	
NPCV		Maximum number of curves/plot	
NN		Subscript counter	
NPLOT		Number of plots	
NPOINT		Number of points on a plot	
NPT		Number of point/curve (array) (CURVE)	
NPT	C	Array containing number of points to be plotted (GRAPH)	
NPTM		Numerical value of NPT	
NQP		Number of quality constituents to be plotted	
NQUAL		Number of quality constituents on data file	
NR		Subscript counter	
NSCRAT	C	Array of variable scratch units	
NSERYS		Demonstration series number	
NSTEPS		Number of steps in plot	
NSTRMS		Number of storms being studied	
NSYM		Plot number	
NTAPE		Input tape number for plotting	
NVAL		Number of points/data record on a file	
N5		Card input unit number	
N6		Print output unit number	
PINE		Subroutine name	
PNAME		Name used to call the blocks of the Storm Water Model	
PPLOT		Subroutine name	
QTRUNK		Maximum flow rate possible in trunk sewer	cfs
RAIN		Amount of rainfall for a storm	
RANGE		Range of y values to be plotted	
RECEIV		Subroutine name	
RUNOFF		Subroutine name	
STORAG		Subroutine name	
STORM		Date of storm	

TABLE 4. (CONT'D)

Variable Name	C*	Description	Unit
TDELT		Time-step interval	
TIMES		Time-step interval	sec
TITL	C	Title printed out with graphs	
TITLE	C	Title printed out on curves	
TITLE1		Title of drainage basin	
TRANS		Subroutine name	
TZERO		Zero time	sec
VERT	C	Vertical label	
X		X coordinate array (CURVE)	
X	C	X coordinate array (GRAPH)	
XA		X increment used for interpolation	
XINT		Label interval for X	
XMAX		Maximum X value	
XMIN		Minimum X value	
XLAB	C	Numerical scale labels for X	
XO		Start point of line (X coordinate)	
XSCAL		X scale factor	
XT		End point of line (X coordinate)	
X1		Same as XO	
X2		Same as XT	
YINT		Label interval for Y	
Y		Y coordinates of curves to be drawn	
Y	C	Y coordinates of curves to be drawn	
YA		Y increment used for interpolation	
YLAB		Numerical scale labels for Y	
YMAX		Maximum Y value	
YMIN		Minimum Y value	
YO		Start point of line (Y coordinate)	
YSCAL		Y scale factor	
YT		End point of line (Y coordinate)	
YT	C	Hydrograph-pollutograph information on data file	
Y1		Same as YO	
Y2		Same as YT	

TABLE 5. SUMMARY OF CONTROL WORDS AND CORRESPONDING ACTION FOR MAIN PROGRAM

Control Word	Action to be taken
RUNOFF	Execute RUNOFF Block
TRANSPORT	Execute TRANSPORT Block
STORAGE	Execute STORAGE Block
RECEIVING	Execute RECEIVING Water Block
COMBINE	Execute COMBINE Block
GRAPH	Produce graphs on line printer
ENDPROGRAM	Terminate run
Any other word	Terminate run with error message

4. RUNOFF BLOCK

4.1 Block Description

4.1.1 Introduction

The RUNOFF Block has been developed to simulate both the quantity and quality runoff phenomena of a drainage basin and the routing of flows and contaminants to the major sewer lines. It represents the basin as an aggregate of idealized subcatchments and gutters. The program accepts an arbitrary rainfall hyetograph and makes a step-by-step accounting of rainfall, snowmelt, infiltration losses in pervious areas, surface detention, overland flow, gutter flow, and the contaminants washed into the inlet manholes, leading to the calculation of a number of inlet hydrographs and pollutographs.

The drainage basin may be subdivided into a maximum of 200 subcatchment areas. These, in turn, may drain into a maximum of 200 gutters or pipes which finally connect to the inlet points for the the TRANSPORT Model. However, the user must be cautioned that if the TRANSPORT Model is to be run also, the total number of sewer elements (conduit and non-conduit) must not exceed 160.* The maximum number of non-conduit elements (manholes) into which there can be input hydrographs and pollutographs** is 70 for the TRANSPORT Model. The maximum number of time steps that may be computed is 150 for both RUNOFF and TRANSPORT. This section describes the program operation of the RUNOFF Block, provides instructions on data preparation and input data card formats, defines RUNOFF Block variables, and shows an example application.

4.1.2 Program operation

The relationships among the subroutines which make up the RUNOFF Block are shown in Figure 3. The subroutine RUNOFF is called by the EXECUTIVE Block to gain entrance to the RUNOFF Block. The program

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* This is the total for the TRANSPORT Model only. Up to 200 additional gutter/pipes may be contained in the RUNOFF.

** These correspond to inlets in the RUNOFF Model.

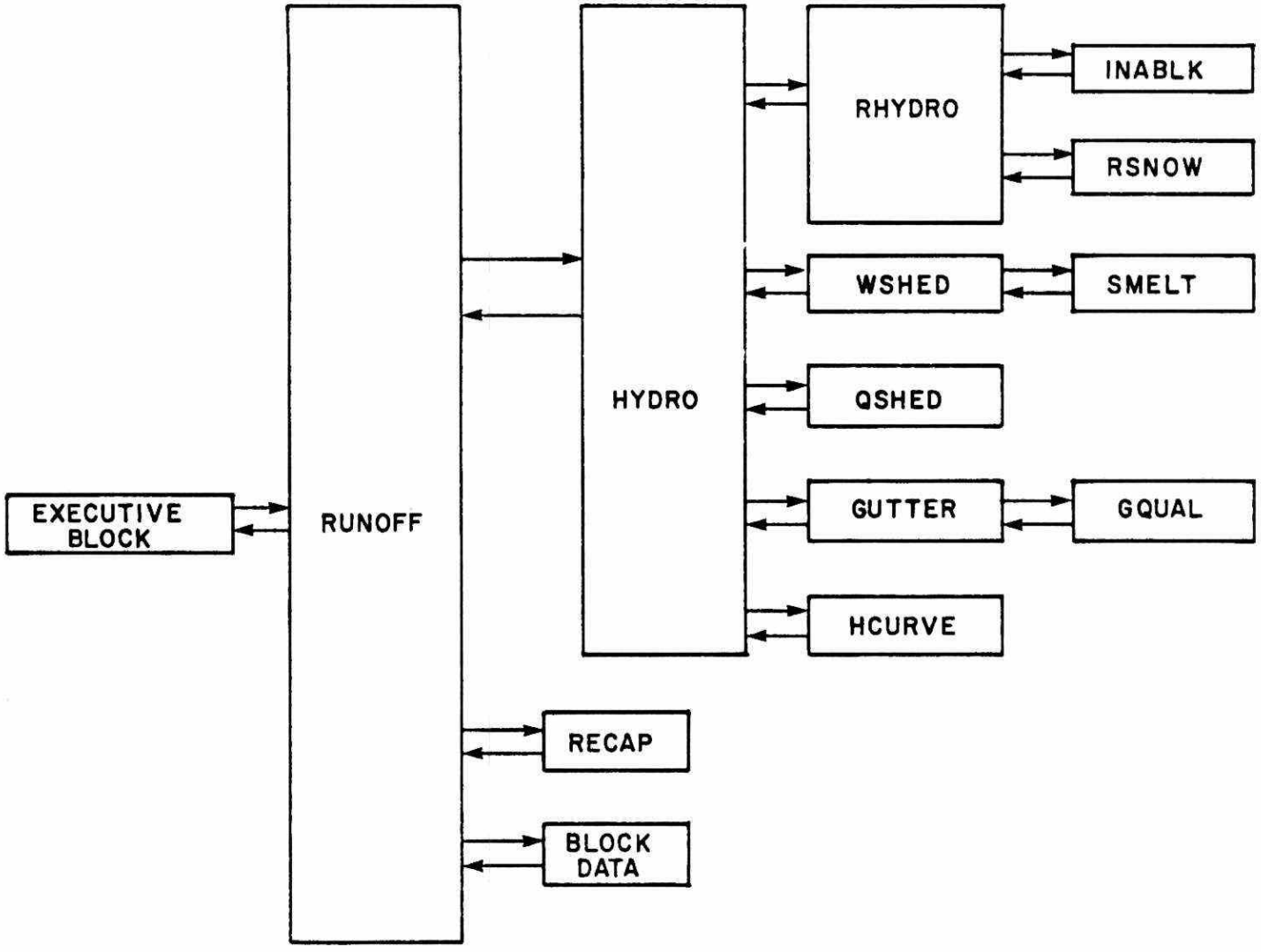


FIGURE 3. RUNOFF BLOCK

prints "ENTRY MADE TO RUNOFF MODEL", and then acts as the driver routine for the Block. Subroutine RUNOFF directly calls subroutines HYDRO and RECAP. Although BLOCK DATA is not actually a subroutine, it is automatically activated by RUNOFF. Its main function is to set the initial pollution loadings such as pounds of pollutant per day per 100 feet of curb, and milligrams of pollutant per gram of dust and dirt. Subroutine RECAP reads tape headers, and prints the table headings and results of the quantity and quality simulations.

Subroutine HYDRO computes the hydrograph coordinates and the wastershed quality contributions with the assistance of four core subroutines, RHYDRO, WSHED, QSHED, and GUTTER. It initializes all the variables to zero before calling RHYDRO to read in the rainfall hyetograph and information concerning the drainage basin. When the option for snowmelt calculations is used, subroutine HYDRO controls the input of additional data such as temperature and snowpack parameters necessary for the computations.

RHYDRO calls subroutine RSNOW to initialize some snowmelt parameters and subroutine SMELT is called from WSHED which estimates snowmelt at each time step. Subroutine INABLK reads in dust and dirt loading rates and pollutant quality factors (mg per gram of dust and dirt) instead of using the values in the BLOCK DATA subroutine, if desired. Next HYDRO sets up an ordering array to sequence the computational order for gutters/pipes according to the upstream and downstream relationships. If quality is to be simulated, QSHED is called to initiate pollutant loads on the watershed.

HYDRO then sets up a DO loop to compute the hydrograph coordinate for each incremental time step. In each step, subroutine WSHED is first called to calculate the rate of water flowing out of the idealized subcatchments. If quality is to be simulated, QSHED is called to compute the watershed quality contributions from catch basins, erosion, dust and dirt, and other sources. If quality is to be simulated in conjunction with the snowmelt simulation, additional information concerning accumulations of chloride and lead are read by subroutine INABLK. GUTTER is then called to compute the instantaneous water depth and flow rate for the gutters/pipes and to route the flow. Water flowing into the inlet point, be it from gutters/pipes or direct drainage from subcatchments, is accumu-

lated to give a hydrograph coordinate. A continuity check is then made for the deposition of rainfall water in the form of runoff, detention storage, and infiltration losses. The error in continuity is computed and printed as a percentage of total rainfall. When the snowmelt option is used, the continuity check also includes the snowmelt water component. With the assistance of subroutine HCURVE, HYDRO plots the rainfall hyetograph and the runoff hydrograph for the drainage basin. Subroutine GQUAL routes pollutants in each gutter/pipe corresponding to the flow values computed in subroutine GUTTER.

4.2 Surface Flows

The core of the RUNOFF Model is the routing of hydrographs through the drainage system. This is accomplished by a combination of overland flow and pipe routing.

Three types of elements are available to the user:

1) subcatchment elements (overland flow),
2) gutter elements (channel flow), and
3) pipe elements (special case of channel flow).

Flow from subcatchment elements is always into gutter/pipe elements, or inlet manholes. The subcatchment elements receive rainfall, account for infiltration loss using Horton's equation, and permit surface storage such as ponding or retention on grass or shrubbery.

If the snowmelt option is used, the snowpack distribution is accounted for by the level of subcatchment discretization. Depending on the condition of the snowpack and the meteorological conditions, the calculated melt plus rainfall can either be stored in the pack or transmitted through the pack and become available for surface storage, infiltration or runoff. If gutter/pipe elements are used, these route the hydrographs from the watershed elements to the inlet to the main sewer system. Pipes are permitted to surcharge when full.

4.3 Surface Quality

The quality of the inlet flows is determined as explained under Program Operation (subroutine QSHED). The quantity of pollutants washed off the land surface of the drainage basin is added to gutter/pipes or

inlet manholes. Initially, the program calculates the amount of contaminants allowed to accumulate on the ground prior to the storm, and then, taking into account rainfall intensity, major land use, and land slope, the washed off pollutants are routed through any gutter/pipes to generate pollutographs at inlet manholes. When the snowmelt option is used, additional calculations for the accumulations of chloride and lead are made. The amount of chloride on the surface is estimated by inputting the total pounds of salt distributed per subcatchment. The accumulated amount of lead is calculated as a function of curb length.

Output from the program consists of hydrographs and pollutographs on tape/disc for use in TRANSPORT Block and printed and/or plotted information for the user. (At the present time only BOD, SS and coliforms may be routed through the TRANSPORT Block after being generated from the RUNOFF Block.)

4.4 Instructions for Data Preparation

Instructions on the use of the RUNOFF Block are divided into two sections, surface flows and surface quality.

4.4.1 Surface flows

Use of the surface flows portion of the RUNOFF Block requires three basic steps:

Step 1 - geometric representation of the drainage basin,
Step 2 - estimate of coefficients,
Step 3 - preparation of data cards for the computer program.

Step 1 - Method of discretization

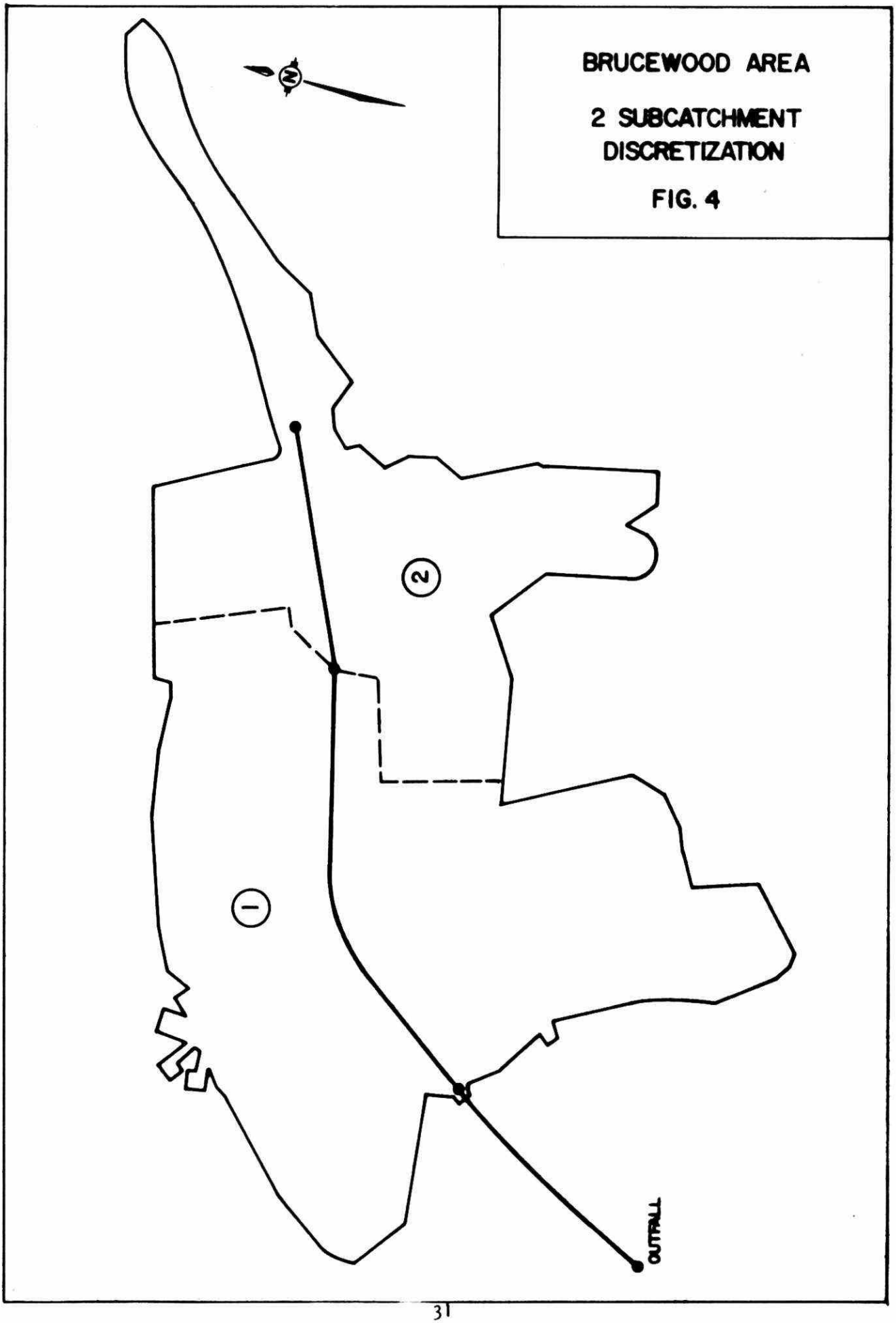
Discretization is a procedure for the mathematical abstraction of the physical drainage system. For the computation of hydrographs the drainage basin may be conceptually represented by a network of hydraulic elements, i.e, subcatchments, gutters and pipes. Hydraulic properties of each element are then characterized by various parameters, such as area, slope and roughness coefficient.

Discretization begins with the identification of drainage boundaries, the location of major sewer inlets and the selection of those gutters/pipes to be included in the system.

A general method of discretization is discussed in detail in the EPA Version II User's Manual for the Northwood Section of Baltimore, Maryland.

The concept of "lumped" catchments is discussed in Chapter 9 of Volume I of this report. Briefly, it is possible to discretize a particular area at varying levels of detail without necessarily affecting the accuracy of the outlet hydrograph. The level of detail employed in any simulation depends on the objectives of the user; if flows at a large number of locations within a catchment are of interest, then a fairly detailed discretization is required; if only the outlet hydrograph is required, a coarse simulation is usually adequate.

To illustrate different levels of discretization, the 48-acre Brucewood catchment was divided into a lumped, 2 subcatchment schematic and a detailed 21 subcatchment schematic. These are indicated on Figures 4 and 5. The data that would be used in flow simulations for the lumped and detailed catchments are compared in Table 6. At both levels of detail the same default values are used for Manning's roughness, depression storage and infiltration. In the detailed representation, major pipes would be modelled in the TRANSPORT Block, whereas the lumped simulation would only require the RUNOFF Block. Because the area draining to the three pipes in the lumped representation is much larger than the area draining to the individual pipes in the detailed representation, it is sometimes necessary to give these pipes a larger "equivalent diameter" to avoid unrealistic surcharging. Also the total length of gutters/pipes is less for the lumped case since the small pipes (less than 36" in this case) are ignored in the lumping process. Comparisons of lumped and detailed simulations are presented in Volume I of this report.


BRUCEWOOD AREA
2 SUBCATCHMENT
DISCRETIZATION
FIG. 4
N
2
1
OUTFALL

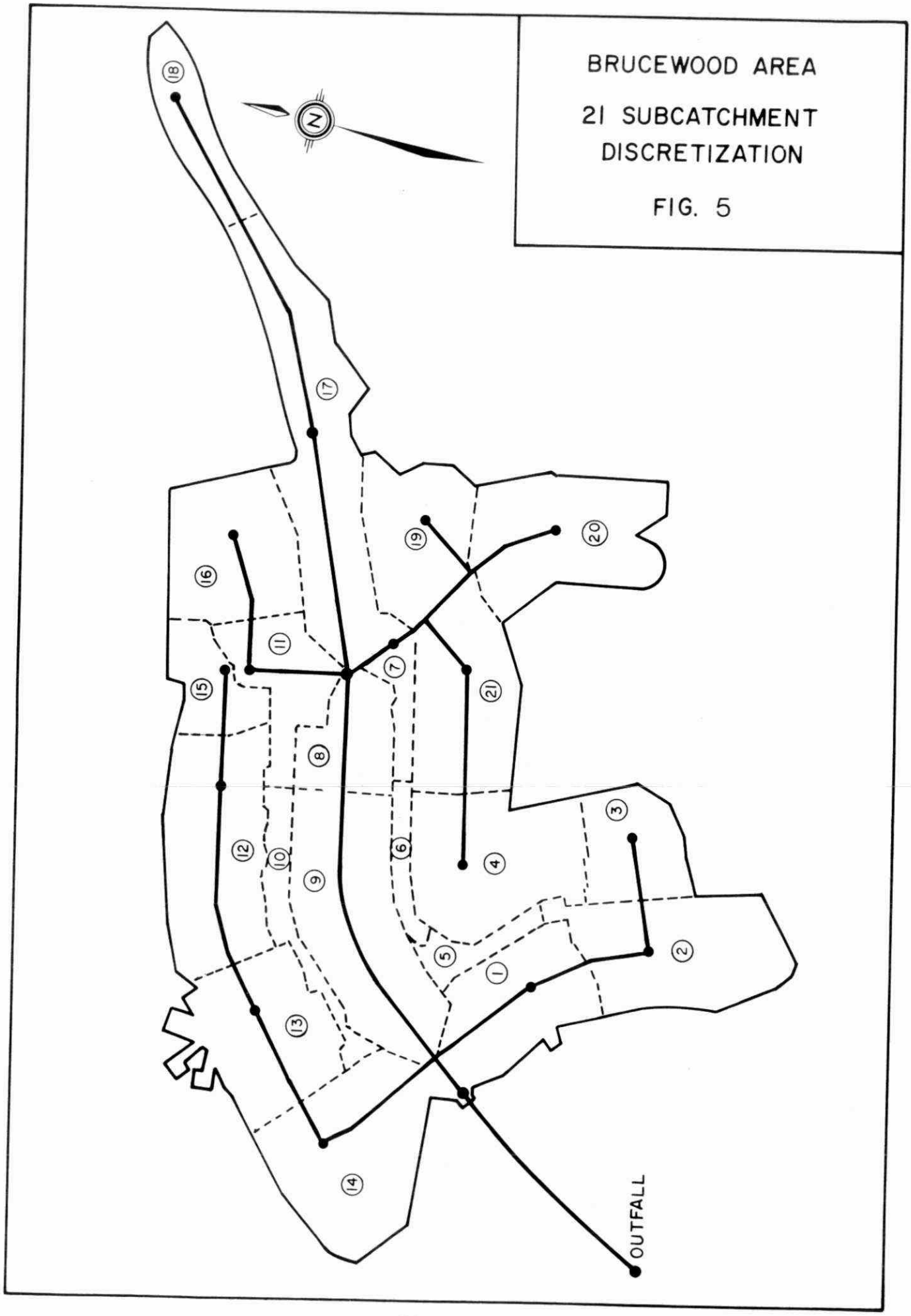

BRUCEWOOD AREA
21 SUBCATCHMENT
DISCRETIZATION
FIG. 5
N
OUTFALL

TABLE 6. LUMPED AND DETAILED REPRESENTATION OF THE BRUCEWOOD CATCHMENT

Variable	Lumped	Detailed
Total Drainage Area (Acres)	48.2	48.2
Number of Subcatchments	2	21
Size of Subcatchments (Acres)	25.1,23.1	0.5-3.8
Imperviousness (%)	47.4	47.4
Total Width of overland flow (Ft.)	4808	4808
Maximum Infiltration Rate (in./hr.)	3.0	3.0
Minimum Infiltration Rate (in./hr.)	0.52	0.52
Horton's Decay Rate (1/sec.)	0.00115	0.00115
Retention Storage for impervious area (in.)	0.062	0.062
Retention Storage for pervious area (in.)	0.184	0.184
Number of Gutters/Pipes in RUNOFF Data	3	33
Manning's Coefficient	0.018	0.018

Step 2 - Estimate of coefficients

Coefficients and parameters necessary to characterize the hydraulic properties of a subcatchment include surface area, approximate total width of overland flow, ground slope, roughness coefficients, detention depths, infiltration rates (maximum, minimum and decay rate), and percent imperviousness. For a given amount of rainfall and snowmelt over the subcatchment, these parameters ultimately determine the outflow rate of surface runoff and the transient water depth over the subcatchment. Since real subcatchments are not rectangular areas experiencing uniform overland flow, average values must be selected for computation purposes. The distribution and amount of snow on snow-covered areas can also affect such runoff properties as surface roughness, detention depths and infiltration rates.

When snowmelt computations are made either the degree-hour melt equation (1) or equation (2) can be used. The degree-hour equation is used during rain-free periods when melt is the only contribution to runoff:

$$M = C(T_A - T_B) \qquad (1)$$

where: C = degree hour melt coefficient,
T_B = base temperature for melt, ^{o}F,
T_A = hourly temperature ^{o}F.

Typical values of the degree-hour melt coefficient and base temperature range from 0.002 to 0.006, and 25 to 32^{o}F, respectively.

The generalized snowmelt algorithm is shown on Figure 6. When there is no rainfall, equation (1) should be used, and the user supplies a melt coefficient and base temperature. Equation (2) is recommended for melt computations during rainy or cloudy periods. The air pressure and vapour pressure are computed internally by the program by using the catchment elevation and the air temperature, and the relationship summarized in Figure 6.

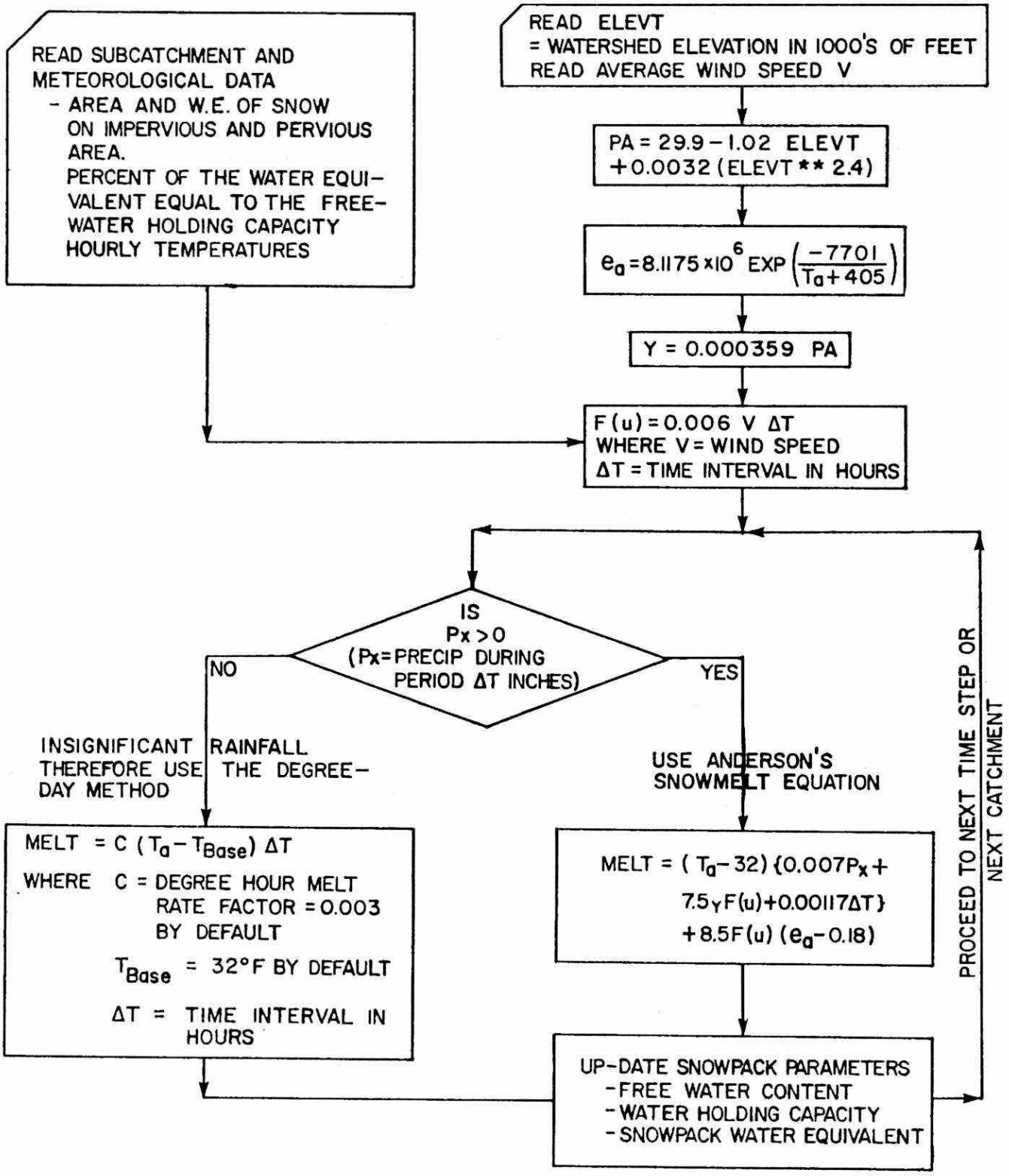

READ SUBCATCHMENT AND METEOROLOGICAL DATA
- AREA AND W.E. OF SNOW ON IMPERVIOUS AND PERVIOUS AREA.
PERCENT OF THE WATER EQUIVALENT EQUAL TO THE FREE-WATER HOLDING CAPACITY
HOURLY TEMPERATURES
READ ELEVT
= WATERSHED ELEVATION IN 1000'S OF FEET
READ AVERAGE WIND SPEED V
PA = 29.9 − 1.02 ELEVT + 0.0032 (ELEVT ** 2.4)
$e_a = 8.1175 \times 10^{6} EXP\left(\frac{-7701}{T_a + 405}\right)$
Y = 0.000359 PA
F(u) = 0.006 V ΔT
WHERE V = WIND SPEED
ΔT = TIME INTERVAL IN HOURS
IS Px > 0 (Px = PRECIP DURING PERIOD ΔT INCHES)
NO
YES
INSIGNIFICANT RAINFALL THEREFORE USE THE DEGREE-DAY METHOD
USE ANDERSON'S SNOWMELT EQUATION
MELT = C ($T_a - T_{Base}$) ΔT
WHERE C = DEGREE HOUR MELT RATE FACTOR = 0.003 BY DEFAULT
T_{Base} = 32°F BY DEFAULT
ΔT = TIME INTERVAL IN HOURS
MELT = (T_a − 32) {0.007 Px + 7.5 γ F(u) + 0.00117 ΔT} + 8.5 F(u) (e_a − 0.18)
UP-DATE SNOWPACK PARAMETERS
- FREE WATER CONTENT
- WATER HOLDING CAPACITY
- SNOWPACK WATER EQUIVALENT
PROCEED TO NEXT TIME STEP OR NEXT CATCHMENT

FIGURE 6. GENERAL ALGORITHM FOR SNOWMELT QUANTITY SUBROUTINE

$$M = (Ta - 32)\ (0.007\ P_x \Delta T + 7.5\ \gamma\ F(u) + .00117\Delta T)$$

$$+ 0.5F(u)\ (e_a - 0.18) \qquad (2)$$

where" M = melt in inches,

Ta = air temperature (^{o}F),

$F(u)$ = wind function = $.006\ V\Delta T$,

V = wind speed, mph,

e_a = vapour pressure of air (inches Hg), (computed by the program),

P_x = rainfall intensity (inches/hour),

γ = .000359 PA,

PA = air pressure (inches Hg), (computed by the program),

ΔT = time interval in hours.

Generally, the most sensitive parameters in the snowmelt calculation based on equation (2) are the air temperature and the wind speed.

The snowpack can retain a certain amount of free water. The free water holding capacity of the snowpack is specified as a percentage of its water equivalent, varying typically from 1.0% to 6.0% of snow water equivalent. A value of 2% or 3% is recommended as a starting point for calibration. The actual percentage of initial free water in the snowpack can either be estimated from observation or assumed to be a calibration parameter which can range from 0% to 6.0%.

The values for Manning's 'n' can be assumed initially to be those in Table 7. Subsequent calibration may increase these values to reflect the delaying effect of the snowpack on the runoff hydrograph.

Infiltration parameters for pervious areas can be those represented by Figure 7 in the absence of additional information. In the absence of information to the contrary, surface depres-

TABLE 7. ESTIMATE OF MANNING'S ROUGHNESS COEFFICIENTS

Ground Cover	Manning's n for Overland Flow
Smooth asphalt	0.012
Asphalt or concrete paving	0.014
Packed clay	0.03
Light turf	0.20
Dense turf	0.35
Dense shrubbery and forest litter	0.40

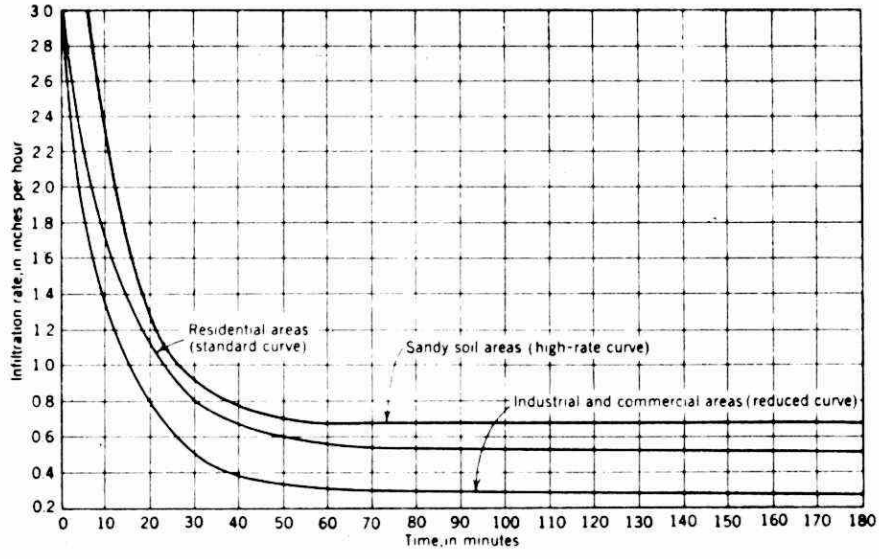


FIGURE 7. STANDARD INFILTRATION-CAPACITY CURVES FOR PERVIOUS SURFACES

sion storage is assumed to be the same for snow-covered areas as for bare surfaces. Depending on local snow cover and ground conditions, some calibration of infiltration and surface depression parameters may be necessary.

After the liquid water available for runoff has been determined, the computation for flow during snowmelt then follows the procedure outlined in the EPA Version II User's Manual. However, the RUNOFF Block has been modified in order to account for runoff from bare areas as well as from snow-covered areas. The description of the snow-covered areas is provided on the input deck (Figure 8).

Step 3 - Data card preparation

The data cards should be prepared according to Figure 8 and Tables 8 and 9, at the end of this section. Figure 8 shows the layout of the data cards, including those for the quality routines, in the order in which they must appear. Tables 8 and 9, respectively, show how the data cards are to be punched, and list the descriptions of variables used in this program Block.

The first step in the data preparation is the determination of the number of time steps to be used and the length of each time step (see Table 8, card group 2). The time step length (integration period) is usually three to five minutes, but may range from one to 30 minutes, depending on the length and intensity of the storm and the degree of accuracy required. The number of time steps is limited to a maximum of 150. Enough time steps should be allowed to extend the simulation past the storm termination and thus account adequately for the storm runoff. Along with the input of time steps, the number of hyetographs for the drainage basin is required. If the percent impervious area with zero detention is known, this value must be supplied; otherwise, the model uses a default value of 25 percent. This ensures an immediate runoff response and a steep rising limb on the inlet hydrograph for the basin. If erosion is to be included

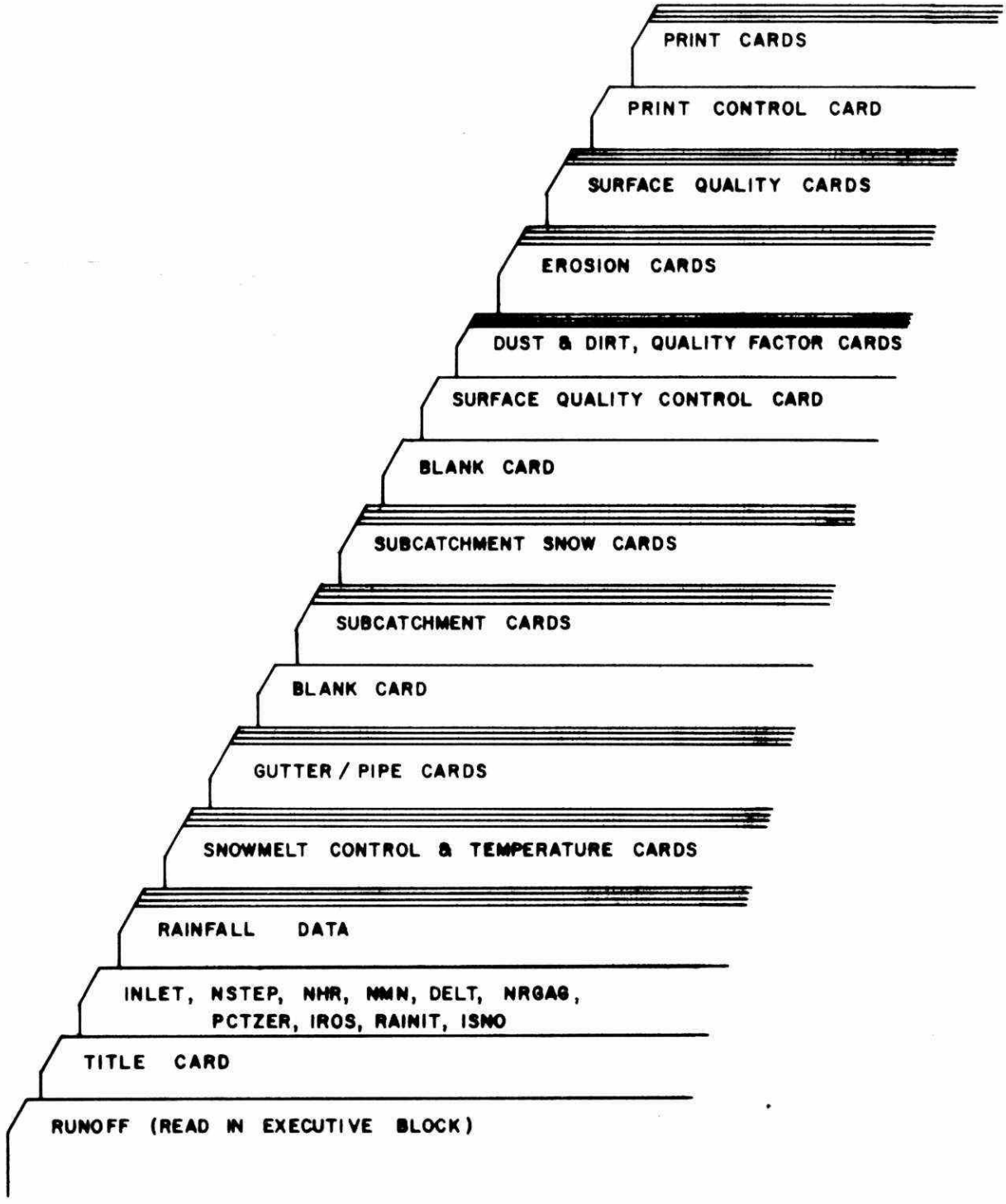


FIGURE 8. DATA DECK FOR THE RUNOFF BLOCK

in the quality simulation, this must be specified in card group 2, and the highest average 30-minute rainfall intensity in inches per hour provided. It is convenient to do this because erosion is a function of a rainfall factor which is, in turn, a function of time interval, intensity, total depth per interval, and the 30-minute rainfall intensity. If snowmelt computations are to be performed, the variable ISNO (card 2) is set to any non-zero integer, and the relevant information pertaining to snowmelt computations provided as described in the following paragraphs.

The rainfall data cards are then prepared for each hyetograph from rainfall records, or are assumed if a hypothetical test case is being run. The time interval need not be the same as the integration period in quantity and quality portions of the RUNOFF Block. If five-minute interval rainfall data are available, they would be preferred over 15-minute interval data because a more accurate runoff hydrograph would be produced. Up to <u>one</u> different hyetograph for each subcatchment may be provided by the user. However, the number of data points and the time interval between values for each hyetograph must remain constant, as specified by the rainfall control card.

Snowmelt computation control information must be supplied on card type 4A if the snowmelt option is selected. If the user selects the degree-hour melt equation, the degree-hour melt rate (DHMR) must be provided and typical values range from 0.002 to 0.006. The base temperature for melt must also be provided, typical values ranging from 25 to 32^{o}F.

If a degree-hour melt rate value is not specified, then an average wind speed (in miles per hour [WIND]) and basin elevation in thousands of feet must be provided for use in the more detailed melt calculation. This equation is recommended for use during rainy or cloudy periods.

For either snowmelt option, the Fahrenheit temperature for each time step is required as input on card group 4B.

The spatial distribution of rainfall and the input data describing the gutter/pipe system are input on card groups 3, 4 and 5 as described in the EPA Version II User's Manual.

If snowmelt is being modelled, information on the makeup and distribution of the snowpack must be supplied for each subcatchment. The percent of pervious and impervious area within each subcatchment which is covered by snow must be estimated. The computations essentially consider two new types of runoff producing areas, namely, the snow-covered pervious and impervious areas. For each of these areas the water equivalent of snow and the ratio of free water holding capacity to the water equivalent must be estimated and supplied. Each subcatchment can be partially or totally covered by snow, depending on the percentages of snow covered area input on card group 8A. It should be noted that card group 8A, describing snow-covered catchments, must be preceded by card group 7 describing the bare catchments, as described in the EPA Version II User's Manual. Finally, Manning's 'n' values for each of these new areas must be supplied.

4.4.2 Surface quality

Data input to this surface quality program is prepared at the same time as for the rest of the RUNOFF Block. Thus, when an inlet drainage basin is selected it may be subdivided into areas containing a single type of land use. Five land uses which may be modelled are: single family residential, multifamily residential, commercial, industrial, and undeveloped or parklands.

The preparation of input for the calculation of all quality parameters except lead and chloride is identical to that described in the EPA Version II User's Manual.

However, the program has been modified to permit direct input of dust and dirt loading rates as well as the pollutant quality factors for all standard pollutants, and additionally for the chloride and lead constituents if snowmelt is being modelled. The standard pollutant factors are read in on card 9C, and the chloride and lead parameters on

card 11. These last two parameters are used when snowmelt is being modelled. Specific formulas have been incorporated into the program to handle these pollutants, and the units of input are total pounds of salt applied in the subarea for chlorides (NACLB) and pounds per 100 ft curb per day for lead (PBRATE).

4.5 Urban Erosion

The required data input for urban erosion is identical to that described in the EPA Version II User's Manual.

4.6 Example Application

A sample application of the RUNOFF Block to the Bannatyne sewer district is included in this section to familiarize the reader with the Canadian version. This area is discussed in some detail in the Volume I - Final Report, where it was used in several parts of the SWMM study.

The Bannatyne area is a medium-sized (542 acres) urban catchment consisting primarily of residential land. In this example, the area was discretized into 41 subcatchments based upon the topographic maps and sewer plans available for the area. The following range of parameters was determined for these subcatchments and has been used in this example:

Area	-	5.1 - 23.1 acres
Percent imperviousness	-	22.4% - 75.0%
Subcatchment slope	-	.002 - .011 ft/ft
Manning's 'n' impervious	-	.013
Manning's 'n' pervious	-	.250
Detention storage, impervious	-	.062"
Detention storage, pervious	-	.184"
Infiltration rate, maximum	-	3.0 in/hr
Infiltration rate, minimum	-	.5 in/hr

The roughness, detention, and infiltration parameters in the above list represent default values. In addition to these, several snowmelt parameters were selected, and also some surface quality parameters, since this example encompasses storm runoff quantity and quality, and snowmelt

calculations. These will be discussed in the descriptions of several (significant) relevant computer-printed tables.

Figure 9 shows the Bannatyne area subdivided into its 41 constituent subcatchments. Each of these was modelled in this example, and the surface runoff hydrographs were subsequently stored for input to the TRANSPORT Block.

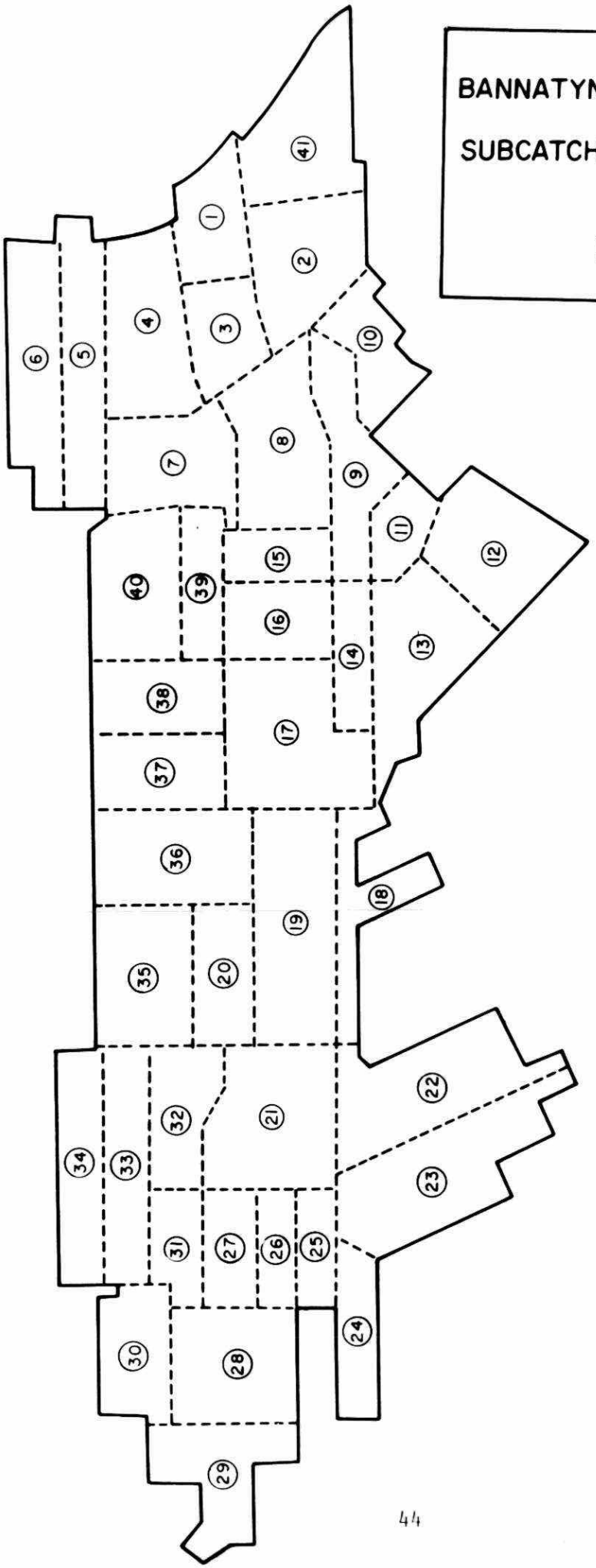
Table 10, at the end of this section, shows the input data cards used in this simulation. The numbers in parentheses to the left of each line of data refer to the card group number used in Table 8 to describe the data formats.

Table 11 shows the first computer printed table from the simulation, which is basically a listing of the input initial control parameters, rainfall data, and snowmelt data. Simulation has been specified for 80, five-minute time steps, long enough to cover the rainfall hyetograph plus a longer snowmelt produced recession curve. A rain-on-snow event was being simulated, and consequently the simplified heat budget equation was used, as indicated by the zero value supplied for the degree-hour melt rate. The rest of the snowmelt input data required, plus the temperature data, completes this table.

Table 12 shows the gutter/pipe input data used in this example. One gutter/pipe was used in each subcatchment to simulate a lateral sewer. The diameter (width) and length of each gutter was determined from the sewer plans. A relatively high Manning's 'n' (0.018) was used to represent these gutters, since this area was not new. The "Gutter Connection" tells the model which "inlet" in the TRANSPORT Block should receive the hydrograph.

Table 13 shows the input subcatchment data. Gutter/pipe simulation was specified, and the third column of Table 13 tells the model which gutter is to receive the hydrograph from each subcatchment.

Table 14 shows the input snowmelt data. The initial snow conditions on the watershed have been set up by specifying the percentage of both pervious and impervious area which is covered by snow, and also the water equivalent of each snowpack. A smaller percent of the impervious area has been specified as snow-covered, representing snow clearing and removal on streets and lots. Initial free water, free water holding capacity, and default resistance values are also shown.



BANNATYNE SEWER DISTRICT

SUBCATCHMENT BOUNDARIES

FIG. 9

Table 15 shows the locations in the TRANSPORT network at which hydrographs will be stored. It also shows basic input quality parameters.

Table 16 shows the input gutter lengths and catch basins for each subcatchment which are used to compute the amount of pollutant source material available at the start of simulation.

Table 17 shows the first output results of the simulation; an overall water balance between all major components of the runoff cycle which may be used to assess the overall simulation. In this simulation, the continuity error was only .09%. The total snowmelt contribution was 260,000 cubic feet, and the total storm water runoff was 405,000 cubic feet.

Table 18 shows the output quantity and quality results for one of the subcatchments. Eight quality constituents were modelled in this example. These hydrographs and pollutographs may be printed for each subcatchment before being stored for use in the TRANSPORT Block.

Figures 10 and 11 show the input rainfall hyetograph and the sum of all the computed subcatchment hydrographs, both "printer plotted" by the computer.

The RUNOFF Block simulation has been completed, and the same example will be continued in the TRANSPORT section.

4.7 Model Sensitivity and Calibration

A knowledge of, or "feel" for, the sensitivity of the model is important both in calibrating or in conducting ordinary simulations, such as in the foregoing example. Although small variations have been reported by different investigators, the following list shows the various hydrologic parameters in approximate order of their significance:

- imperviousness,
- width of overland flow,
- infiltration,
- surface retention depth,
- Manning's 'n',
- ground slope.

In addition to their relative significance, each parameter may also affect, by differing amounts, the two basic components of the simulated hydrograph: peak flow, and runoff volume. According to the underlying model theory, certain of these parameters (Manning's 'n', slope, overland flow width) are involved in the computation of the runoff rate in each time step, whereas others (infiltration, surface retention) are involved with the amount of rainfall losses in each time-step. It is logical, therefore, that the former group of parameters would most influence the peak of the computed flow hydrographs, and the latter group the volume. Percent imperviousness affects both flow and volume of the runoff hydrograph. These effects were demonstrated in Volume I of this report using several sensitivity simulations.

Calibration of the model against measured data involves adjusting one or more of these parameters to improve the agreement. Obviously, adjusting the proper parameter will achieve the best calibration in the shortest time. For example, if there is a sustained discrepancy between measured and computed flow rates over the simulation, then an adjustment of the imperviousness might be indicated. It is difficult to measure imperviousness accurately because some paved areas drain to grassed areas, or otherwise may not be directly connected to the sewer system. On the other hand, if only the initial part of the hydrograph is not well simulated, then the user might adjust the initial rate of infiltration. Truly, it is only through doing several simulations that the user can develop a good "feel" for how the model behaves.

During this study, and in other simulations, the SWMM default values were found to give reasonably good results. In fact, no calibration was required in several cases. Therefore, no changes in the RUNOFF Block default values were made or suggested. Practical ranges of the model parameters that were used in this study and other recent simulations are as follows:

Imperviousness, 5% - 95%

Infiltration rates, max. 3"/hr - 6"/hr,
min. 25"/hr - 1"/hr

Retention storage, pervious .10" - .2"
impervious .05" - .10"

Resistence factors, pervious .25 - .375
impervious .013 - .030

Percent of area with zero detention, 25% - 50%

Additional discussion of model sensitivity and calibration is contained in Volume I of this report and also in the EPA Version II User's Manual.

TABLE 8. RUNOFF BLOCK CARD DATA

Card Group	Format	Card Columns	Description	Variable Name	Default Value
1	20A4		Title cards: two cards with TITLE heading to be printed on output.		Blanks
2			Control card: one card		
	2I5	1-5	Basin identification number	IBASIN	0
		6-10	Number of time-steps to be calculated (Maximum = 150)	NSTEP	None
	I3	11-13	Hour of start of storm (24-hour clock)	NHR	0
	I2	14-15	Minutes of start of storm	NMN	0
	F5.0	16-20	Integration period (time step), min.	DELT	None
	I5	21-25	Number of hyetographs (rain gauges)	NRGAG	None
	F5.0	26-30	Percent of impervious area with zero detention (immediate run-off)	PCTZER	25.0
	I5	31-35	IROS = 1, Erosion for subcatchment is to be modelled	IROS	0
	F5.0	36-40	If IROS = 1, Highest average 30-minute rainfall intensity, in/hr.	RAINIT	0.0
	I5	41-45	If ISNO ≠ 0 Snowmelt is called	ISNO	0
3			Rainfall control card.		
	I5	1-5	Number of data points for each hyetograph (maximum = 200)	NHISTO	None
	F5.0	6-10	Time interval between values min.	THISTO	None

TABLE 8. (CONT'D)

Card Group	Format	Card Columns	Description	Variable Name	Default Value
Note: The Runoff block requires only one scratch data-set. All non-decimal numbers must be right-justified.					
			REPEAT CARD GROUP 4 FOR EACH HYETOGRAPH.		
4			Rainfall hyetograph cards: 10 intervals per card (Maximum number of values = 200).		
	10F5.0	1-5	Rainfall intensity, first interval, in/hr	RAIN(1)	None
		6-10	Rainfall intensity, second interval, in/hr	RAIN(2)	None
		11-15	Rainfall intensity, third interval, in/hr	RAIN(3)	None
		16-20	Rainfall intensity, fourth interval, in/hr	RAIN(4)	None
		.		.	
		.		.	
		.		.	
		.		.	
		.		.	
4A			Snow Control Card Include card 4A if ISNO ≠ 0 on card 2		
	4F10.0	1-10	Degree hour melt rate. If this field is zero or blank the DHMR method is not used for snow melt, snow melt is calculated using wind, elevt., and rain.	DHMR	0
		11-20	Snow melt base temperature	TBASE	None
		21-30	Wind speed (MPH)	WIND	0
		31-40	Elevation of area (in thousands of feet ie 1000 ft = 1.0)	ELEVT	0

TABLE 8. (CONT'D)

Card Group	Format	Card Columns	Description	Variable Name	Default Value
4B			TEMPERATURE AT EACH TIME STEP Include only if ISNO ≠ 0 on card 2		
			16 intervals per card (maximum number of values = 200)		
	16F5.0	1-5	Temperature in degrees fahrenheit for first interval	TEMP(1)	0
		6-10		TEMP(2)	
		.		.	
		.		.	
				TEMP (NSTEP)	
			REPEAT CARD 5 FOR EACH GUTTER/PIPE.		
5			Gutter/pipe cards: one card per gutter/pipe (if none, leave out) (maximum number = 200).		
	I10	1-10	Gutter/pipe number.[b]	NAMEG	None
	2I5	11-15	Gutter or inlet number for drainage.[b]	NGTO	None
		16-20	= 1 for gutter, = 2 for pipe.	NP	None
	7F8.0	21-28	Bottom width of gutter or pipe diameter, ft.	GWIDTH=G1	None
		29-36	Length of gutter, ft.	GLEN =G2	None
		37-44	Invert slope, ft/ft.	GSLOPE=G3	None

[a] Problems may occur when zero rainfall occurs several time-steps before the actual start of the rainfall (the computer underflows).

[b] Numbers may be arbitrarily chosen. However, if inlet number is to correspond to inlet manhole for Transport Block, it must be $\leq$ 1000. The maximum total number of inlets must be $\leq$ 50 for input to Receiving or $\leq$ 70 for input to Transport.

TABLE 8. (CONT'D)

Card Group	Format	Card Columns	Description	Variable Name	Default Value
		45-52	Left-hand side slope, ft/ft.	GS1 =G4	None
		53-60	Right-hand side slope, ft/ft.	GS2 =G5	None
		61-68	Manning's coefficient.	GN =G6	0.018
		69-76	Depth in gutter when full, in.	DFULL=G7	10.0
6			Blank card to terminate gutter cards: one card (must always be included).		
			REPEAT CARD 7 FOR EACH SUBCATCHMENT.		
7	3I5	1-5	Hyetograph number (based on the order in which they are read in).	JK	1
		6-10	Subcatchment number.[a]	NAMEW	None
		11-15	Gutter or manhole number for drainage.[a,b]	NGTO	None
	10F5.0	16-20	Width of subcatchment, ft. This term actually refers to the physical width of overland flow in the subcatchment and may be obtained as illustrated under Instructions for Data Preparation.[c]	WWIDTH=W1	None

[a]Numbers may be arbitrarily chosen. However, if inlet number is to correspond to inlet manhole for Transport Block, it must be $\leq$1000. The maximum total number of inlets must be $\leq$70 for input to Transport or $\leq$50 for input to Receiving.

[b]Need one inlet or gutter/pipe for each subcatchment basin.

[c]As an approximation, twice the length of the principal drainage conduit through the subcatchment may be used.

TABLE 8. (CONT'D)

Card Group	Format	Card Columns	Description	Variable Name	Default Value
		21-25	Area of subcatchment, acres.	WAREA =W2	None
		26-30	Percent imperviousness of subcatchment.	PCIMP =W3	0.001
		31-35	Ground slope, ft/ft.	WSLOPE=W4	0.030
		36-40	Impervious area.) Resistance Factor	W5 =W5	0.013
		41-45	Pervious area.) (Manning's 'n')	W6 =W6	0.250
		46-50	Impervious area.)	WSTORE=W7	0.062
		51-55	Pervious area) Retention storage, (in.)	WSTORE=W8	0.184
		56-60	Maximum infiltration rate, in/hr.	WLMAX =W9	3.00
		61-65	Minimum infiltration rate, in/hr.	WLMIN =W10	0.52
	F10.5	66-75	Decay rate of infiltration in Horton's equation, 1/sec	DECAY =W11	0.00115
8			Blank card to terminate subcatchment cards: one card.		
8A			SNOW SUBCATCHMENT DESCRIPTIONS		
			Include only if ISNO ≠ 0 on card 2		
	I5	1-5	Subcatchment number (all subcatchments in card type 7 must be included. They must both be in the same order) If JK = -1 the rates for W12 - W19 are changed. If JK = -2 the default values are changed.	JK	0
	9F5.0	6-10	Percent of Impervious Area covered by snow	W12	0
		11-15	Water equivalent of snow on area W12 (in.)	W13	0
		16-20	Percent of pervious area covered by snow	W14	0

TABLE 8. (CONT'D)

Card Group	Format	Card Columns	Description	Variable Name	Default Value
		21-25	Water equivalent of snow on area W14 (in.)	W15	0
		26-30	Ratio of free water holding capacity to water equivalent of snow on W12 (Percent)	W16A	None
		31-35	Ratio of free water holding capacity to water equivalent on W14 (Percent)	W16B	None
		36-40	Ratio of initial free water to water equivalent (Percent)	W17	3.0
		41-45	Mannings N for area W12	W18	.013
		46-50	Mannings N for area W14	W19	.25
9			SURFACE QUALITY CONTROL CARD		
	I10	1-10	Surface Quality NQS = 0, no quality modelled NQS = 1, quality to be modelled	NQS	0
			******** THE FOLLOWING PARAMETERS ******* ARE NEEDED ONLY IF NQS = 1:		
	2F10.0	11-20	Number of dry days prior to this storm in which the accumulative rainfall is less than 1.0 inch.	DRYDAY	0.0
		21-30	Street cleaning frequency, days	CLFREQ	0.0
	I10	31-40	Number of Street sweeper passes	NPASS	0
	2F10.0	41-50	Catchbasin Storage volume, ft^3.	CBVOL	0.0
		51-60	Concentration of BOD (mg/l), of the stored water in each catchbasin (100 recommended)	CBFACT(4)	0.0

TABLE 8. (CONT'D)

Card Group	Format	Card Columns	Description	Variable Name	Default Value
	I5	61-65	Method for calculating suspended solids ISS = 0, same as for all other pollutants (Vol. I). ISS = 1, special technique. Same as in original Release 1 of the SWMM.	ISS	0
	I5	66-70	If IABLK ≠ 0 calls initialize routine =1 reads DDFACT =2 reads DDFACT & QFACT & PNAME	IABLK	0
			ABLK DEFAULTS		
9A			DDFACT VALUES Include if IABLK ≠ 0 on card 9		
	5F10.0	1-10	Dust and dirt factor land type 1	DDFACT(1)	0
		11-20	Dust and dirt factor land type 2	DDFACT(2)	0
		21-30	Dust and dirt factor land type 3	DDFACT(3)	0
		31-40	Dust and dirt factor land type 4	DDFACT(4)	0
		41-50	Dust and dirt factor land type 5	DDFACT(5)	0
9B			Include cards 9B, C, if IABLK ≠ 0 or 1 on card 9		
	I10	1-10	Number of pollutants for quality factors	NQS	0
9C			Repeat card 9C for each pollutant		
	5F10.0	1-10	Quality Factor for Pollutant 1 for land type 1	QFACT(1,1)	
		11-20	Quality Factor for Pollutant 1 for land type 2	QFACT(2,1)	
		21-30	Quality Factor for Pollutant 1 for land type 3	QFACT(3,1)	
		31-40	Quality Factor for Pollutant 1 for land type 4	QFACT(4,1)	
		41-50	Quality Factor for Pollutant 1 for land type 5	QFACT(5,1)	

TABLE 8. (CONT'D)

Card Group	Format	Card Columns	Description	Variable Name	Default Value
	2X,2A4	53-60	Name of Pollutant 1[a]	PNAME(1)	
10			Erosion card. If IROS = 0 on Card 2, SKIP to CARD 11. REPEAT CARD 10 FOR EACH SUBCATCHMENT.		
	I5	1-5	Subcatchment number (must be read in same order as Card Group 7)	N	None
	5F5.0	6-10	Area of subcatchment subject to erosion, acres.	ERODAR(N)	0.0
		11-15	Flow distance in feet from point of origin of overland flow over erodable area to point at which runoff enters gutter or manhole.	ERLEN(N)	0.0
		16-20	Soil factor 'K'.[a]	SOILF(N)	0.0
		21-25	Cropping management factor 'C'.[b]	CROPMF(N)	0.0
		26-30	Control practice factor 'P'.[c]	CONTPF(N)	0.0
11			SUBCATCHMENT SURFACE QUALITY DATA CARDS (one card per subcatchment and must be read in the same order as Card Group 7). If NQS = 0, skip to Card 12.		
	5X	1-5	Not used.		
	2I5	6-10	Subcatchment number	N	None

[a]Refer to EPA Version II User's Manual for order of pollutant input.

[b]See instructions for data preparation

[c]See instructions for data preparation and consult with local Soil Conservation Service or Agricultural Research Service experts.

TABLE 8. (CONT'D)

Card Group	Format	Card Columns	Description	Variable Name	Default Value
		11-15	Land use classification. = 1, For single family residential = 2, For multiple family residential = 3, For commercial = 4, For industrial = 5, For undeveloped or park lands.	KL	5
	2F10.0	16-25	Number of catchbasins in subarea.	BA	None
		26-35	Total length of all gutters within subarea, hundreds of feet.	GQ	None
		36-45	Total pounds of salt applied in sub-area	CLLBS	None
		46-55	Loading factor for lead in lb per 100 ft of curb/day	PBRATE	None
12			GUTTER/INLET PRINT CONTROL: ONE CARD		
	2I5	1-5	Number of gutters/inlets for which flows are to be printed (maximum = 200).	NPRNT	0
		6-10	Number of time-steps between printings	INTERV	None
13			IF NPRNT = 0, SKIP CARD 13. GUTTER/INLET PRINT CARDS: 16 VALUES/CARD.		
	16I5	1-5	Gutter/inlet numbers for which flows and/or pollutants are to be printed.	IPRNT(1)	None
		6-10		IPRNT(2)	None
		11-15		IPRNT(3)	None
		.		.	
		.		.	
		.		.	
		.		.	
		.		IPRNT(NPRNT)	None

TABLE 9. RUNOFF BLOCK VARIABLES[a]

Variable Name	C*	Description	Units
A		SS removing coefficient	
ASUB	C	Area of subarea	acre
ATOT	C	Total area of subarea draining to all inlets	acre
AVAIL		Fraction of total dust and dirt available at start of time-step	
AVGFLO	C	Average runoff within a time-step	cfs
AX0		Trapezoidal cross-sectional area, starting	sq ft
AX1		Trapezoidal cross-sectional area, final	sq ft
B		SS removing coefficient	
BOD	C	BOD removed at each time-step to the inlet	lb/DT
BODNS		Non-soluble BOD from dust and dirt removed during each time-step	lb/DT
C	C	Removing coefficient	
CBASTM	C	BOD removed during one time-step including both catchbasin and surface area	lb/DT
CBBOD		Concentration of BOD in each catchbasin	mg/L
CBCENT		Pollution removed from the catchbasin	%
CBDEN		Density of catchbasins	No./acre
CBINC	C	BOD removed from catchbasins during one time-step	lb/DT
CBLBS	C	BOD remaining after each time-step	lb
CBNUM		Number of catchbasins within a subarea	
CBSUM	C	Sum of the drainage to catchbasin in each time-step	gal.
CBVOL		Volume of liquid remaining in a catchbasin	gal.
CCOLI	C	Concentration of coliform bacteria of a subarea during one time-step	MPN/100 ml
CLEAN		Number of cleanings since last storm	
CLFREQ		Frequency of street sweepings	
CONBOD		Average concentration of BOD during each time-step	mg/L
CONCSS		Average concentration of SS during each time-step	mg/L
CONVER		Factor for converting lb/DT/cfs to mg/L	
CONV2		Integer that converts flow unit from cfs to 100 ml/min	
CURVE		Name of subroutine	
D		Computational variable, internal	
DAX1		Change in trapezoidal cross-sectional area	sq ft
DCORR		Time-step water depth	ft
DD		Dust and dirt accumulation rate for each subarea	
DDELV		Rate of change in volume change	
DECAY	C	Exponential decay rate for infiltration	1/sec
DEL		Time-step change in depth of watershed flow	
DELD	C	Instantaneous pipe diameter in radians	radian
DELR		Newton-Raphson change in depth for correction	
DELT	C	Integration time interval	sec, min
DELT2	C	One half of a time-step	min
DELV		Average volume change	

[a] Does not include variables added during updating.

*C = Variable names shared in common blocks.

TABLE 9. (CONT'D)

Variable Name	C*	Description	Units
DF		Sum of volume change plus flow change times time	
DFLOW1		Change in flow	
DFULL		Gutter's maximum depth (for pipes DFULL = 2.62)	in.
DO		Instantaneous depth	ft
DRAIN		Runoff to each catchbasin during each time-step	gal.
DRYDAY		Number of dry days prior to storm	days
DT		Time-step interval	min
DUMMY	C	Dummy common block	
DWP1		Change in wetted perimeter	
D1		Estimated final depth	in.
E		Hundred times average runoff	
ENDTIM		Time of simulation, 24 hour clock	hr
ERROR		Name of error statement	
ERT		Computational variable	
EXPON		Computational variable	
F		Newton-Raphson volume correction (WSHED)	
F		SS removed during one time-step (SFQUAL)	lb/DT
FLOW		Average flow	cfs
FLOWO		Starting flow	cfs
FLOW1		Final flow	cfs
GCON	C	Manning's equation less hydraulic radius	
GDEPTH	C	Instantaneous gutter depth	in.
GFLOW	C	Gutter flow	cfs
GLEN	C	Length of gutter/pipe	ft
GN	C	Manning's roughness coefficient	
GRAPH	XP	Name of subroutine	
GS		Factor in a geometric series	
GSLOPE	C	Slope of gutter/pipe	ft/ft
GS1	C	Gutter side slope, left	ft/ft
GS2	C	Gutter side slope, right	ft/ft
GUTTER	C	Length of gutter in subarea	100-ft
GWIDTH	C	Pipe diameter or gutter width	ft
G1		Read in value of bottom width of gutter or pipe diameter	ft
G2		Read in value of length of gutter	ft
G3		Read in value of invert slope	ft/ft
G4		Read in value of left-hand side slope	ft/ft
G5		Read in value of right-hand side slope	ft/ft
G6		Read in value of Manning's coefficient	
G7		Read in value of depth of gutter when full	in.
HCURVE		Name of subroutine	
HGRAPH	C	Magnitude of variable to be printed in vertical coordinate of the curve	
HISTOG	C	Length of histogram expressed in time	sec
HORIZ	C	Horizontal title unit of hydrograph in time	hr

TABLE 9. (CONT'D)

Variable Name	C*	Description	Units
HTIME	C	Time interval to be printed in the horizontal coordinate of the curve	
HYDRO		Name of subroutine	
I		Bookkeeping integer	
IA		Do loop counter	
IFLG		Surcharge indicator	
IFPRNT		Name of scratch tape	
IHOUR		Hour of start of storm, 24-hour clock	hr
II		Bookkeeping integer	
IJ		Bookkeeping integer	
IK		Bookkeeping integer	
IKOUNT	C		
IMIN		Minute of start of storm	min
INCNT	C	Name of the tape	
IND		Bookkeeping integer, time interval	
INLET		Inlet number	
INPT		Variable which transfer program from tape to compiler	
INPUT	C	Inlet number	
INTCNT		Printing counter	
INTERV	C	Interval integrization cycles for printed hydrographs	
IOUTCT	C	Name of the tape	
IPOINT	C	Internal pointer	
IPRNT	C	Points for which hydrograph will be printed	
ISAVE	C	Points for which hydrograph will be saved	
ISKIP		Number of inlets minus one	
ISUB		Bookkeeping integer	
J		Bookkeeping integer	
JIN	C	Name of input tape	
JJ		Bookkeeping integer	
JK		Bookkeeping integer	
JKL		Do loop counter	
JM	C	Number of input manholes	
JOUT	C	Name of output tape	
JT		Bookkeeping integer	
K		Bookkeeping integer	
KHOUR		Hour of start of storm, 24-hour clock	
KK		Bookkeeping integer	
KL		Do loop counter	
KLAND	C	Land use	
KMIN		Minute of start of storm	min
KNUM	C	Temporary subarea number reset to inlet number	
KOUNT		Computational counter	
KSKIP		Do loop counter for SKIPN	
KSPOT		Bookkeeping integer	
KTNUM		Number of subarea	
KTSTEP		Time-step counter	

TABLE 9. (CONT'D)

Variable Name	C*	Description	Units
L		Bookkeeping integer	
LL		Bookkeeping integer	
M		Bookkeeping integer	
MKOUNT		Computational counter	
MM		Bookkeeping integer	
N		Bookkeeping integer	
NAMEW	C	External subcatchment number	
NCLEAN		Number of cleanings since last storm	
NEW		Bookkeeping integer	
NEXDAY		Number of days after start of storm simulation ends	day
NG	C	Number of gutters	
NGAGP		Number of graphic point	
NGOTO		Gutter number to which watershed drains	
NGTOG	C	Gutter connections	
NGTOI	C	Inlet connections	
NGUT	C	Bookkeeping integer	
NHISTO	C	Number of rainfall time interval	
NHR		Hour of the start of storm	hr
NHYET	C	Number of hyetograph	
NIN	C	Maximum number of gutters draining to gutter, and watersheds draining to gutter	
NING	C	Do loop counter	
NINLTS		Total number of inlets	
NMN		Minutes of the start of storm	min
NOG	C	Total number of gutters/pipes	
NOLD		Bookkeeping integer	
NOPASS		Number of street sweeper passes	
NOUT		Output file variable	
NP		Read in value of NPG	
NPG	C	Control switch for type of gutter, 1=regular, 2=pipe, 3=dummy connected directly to inlet	
NPRINT		Number of time-steps between printing	
NPRNT	C	Number of points where hydrographs are printed	
NPT	C	Number of points to be plotted	
NQUAL		Number of quality constituents used as zero in Runoff quantity	
NRAIN	C	Number of rainfall	
NRANVL		Rain data points limiter	
NRGAG	C	Number of hyetographs	
NSAVE	C	Number of points where hydrographs are saved	
NSCRAT	C	Name of the tape	
NSHED	C	Number of the watershed	
NSPOT		Bookkeeping integer	
NSTEP	C	Number of time-steps	
NSTOP		Error switch	
NTIMEH		Hour of day of simulation (24-hour clock)	hr

TABLE 9. (CONT'D)

Variable Name	C*	Description	Units
NFQUAL		Scratch output file indentifier	
NTSTEP		Number of time-steps modeled	
NTYPE		Number of types	
NUSTEP		Number of printed hydrograph points	
NW	C	Number of watershed	
NWTOG	C	Gutter connection	
NWTOI		Inlet connection	
NX		Bookkeeping integer	cfs
OBIZ		Horizontal title unit for hydrograph in time	hr
OUTFLW	C	Flow out of the gutter	cfs
P			
PCIMP	C	Percent imperviousness of watershed	%
PCNTCB		Percent removal of BOD by catchbasin of one subarea	%
PCNTSS		Percent removal of SS from total dust and dirt of one subarea	%
PCTBOD		Percent removal of BOD from available surface BOD of one subarea	%
PCTZER	C	Percent of impervious area with zero detention depth	%
PO	C	Soluble BOD in dust and dirt	lb
POCB		Total BOD available from catchbasins	lb
POOCB		BOD available in each catchbasin at start	lb
POP	C	BOD removed from dust and dirt during one time-step	lb/DT
POPSS	C	SS removed during one time-step	lb/DT
QIN	C	Input from upstream gutter	cfs
QSUR	C	Surcharge	cf
RADO		Starting hydraulic radius	ft
RAD1		Final hydraulic radius	ft
RAIN	C	Rainfall	in./hr
REFF		Street sweeper removal efficiency	percent, decimal
REMDD	C	Remaining dust and dirt after each time-step	lb
RNYDRO		Name of subroutine	
RI	C	Instantaneous rainfall rate	in./hr
RLOSS	C	Infiltration loss, instantaneous	in./hr
RUNCFS	C	Instantaneous runoff for each inlet	cfs
RUNOFF		Average runoff over a time-step	in./hr
RUNTMP	C	Flow entering input manholes	cfs
SFCOLI	C	Total coliform in runoff	MPN/min
SFQUAL		Name of subroutine	
SKIP1		Scratch tape variable, unformatted	
SKIP2		Scratch tape variable, unformatted	
SKIP3		Scratch tape variable, unformatted	

TABLE 9. (CONT'D)

Variable Name	C*	Description	Units
SKIP4		Scratch tape variable, unformatted	
SKIP5		Scratch tape variable, unformatted	
SKIP6		Scratch tape variable, unformatted	
SKIP7		Scratch tape variable, unformatted	
SS	C	Suspended solids	lb
SUMBOD		Sum of total surface BOD in each area	lb
SUMCB		Sum of total BOD in catchbasins	lb
SUMDD		Sum of the dust and dirt	lb
SUMI	C	Total infiltration into ground	cf
SUMOFF	C	Total gutter flow @ inlet manhole	cf
SUMQW	C	Total flow for each subcatchment	cf
SUMR	C	Total rainfall	cf
SUMST	C	Total surface storage	cf
T		Time-step interval	hr
TAREA		Total area	acres
TBOD		Total BOD in surface runoff	lb
TCBAST	C	Total BOD removed for each inlet	lb
TCBINC	C	Total BOD removed from catchbasins for each inlet	lb
TCCOLI	C	Total concentration of coliform during one time-step	MPN/ 100 ml
TGS		Sum of the gaussetric series plus 1.0	
THISTO		Time of rainfall time intervals	min

Variable Name	C*	Description	Units
TIME	C	Time	sec
TIMEN		Time of simulation (24-hour clock)	min
TIMES		Time of simulation (SFQUAL)	sec
TIME2	C	Time minus half-step	sec
TITEL		Description of curve in horizontal coordinates	
TITL		Description of curve in vertical coordinate	
TITLE	C	Description of problem	
TMAX		Maximum time to be printed in curve	hr
TMINS		Time-step interval	min
TOTDD	C	Total dust and dirt on ground at start of storm for each inlet	lb
TPCBOD		Percent of total BOD removed from each area	%
TPCTBD		Total percent removal of BOD from catchbasin of all areas	%
TPCTCB		Total percent removal of BOD from catchbasin and surface of all areas	%
TPCTSS		Total percent removal of SS from surface of all areas	%
TPOP	C	Total BOD removed from dust and dirt for each inlet	lb
TPOPSS	C	Total SS removed for each inlet	lb
TPTBOD		Total percent removal of BOD from surface of all areas	%
TRAIN	C	Time when rainfall ends	min, sec
TSEC		Time-step interval	sec
TSMBD		Sum of total BOD for the study area	lb

TABLE 9. (CONT'D)

Variable Name	C*	Description	Units
TSUMCB		Sum of the original dust and dirt available in the catchbasin	lb
TSUMDD		Sum of the original dust and dirt available on surface drainage area	lb
TTCBNC		Total removal of BOD from all of catchbasin and surface area	lb
TTCBST		Total removal of BOD of all catchbasins	lb
TTPOP		Total removal of BOD from all surface area	lb
TTPPSS		Total removal of SS of all areas	lb
TZERO		Starting time of the hydrograph	sec
VER		Vertical title unit for hydrograph	in./hr
VERT	C	Vertical title unit for hydrograph	in./hr
WAR		Impervious area of watershed with immediate runoff	sq ft
WAREA	C	Area of watershed	acres, sq ft
WCON	C	Modified Manning's equations, impervious and pervious portions of watershed	
WDEPTH	C	Instantaneous depth on watershed	ft
WFLO		Average watershed flow during time interval	cfs
WFLOW	C	Instantaneous flow from watershed	cfs
WLMAX	C	Maximum infiltration rate	in./hr
WLMIN	C	Minimum infiltration rates	in./hr
WN	C	Dummy variable	
WPO		Wetted perimeter, starting	ft
WP1		Wetted perimeter, final	ft
WSHED		Name of subroutine	
WSLOPE	C	Average slope of watershed	ft/ft
WSTORE	C	Minimum and maximum storage depth on surface of watershed	ft
WWIDTH	C	Average width of watershed	ft
W1		Read in value of the average width of watershed	ft
W2		Read in value of the area of watershed	acre
W3		Read in value of the percent of imperviousness	%
W4		Read in value of slope of watershed	ft/ft
W5		Resistance factor for impervious area	
W6		Resistance factor for pervious area	
W7		Retention storage for impervious area	in.
W8		Retention storage for pervious area	in.
W9		Read in value of maximum infiltration rate	in./hr
W10		Read in value of minimum infiltration rate	in./hr
W11		Read in value of decay rate of infiltration	1/sec
X	C	Number of time interval used in the horizontal coordinate	
XLAB	C	Minimum point in the horizontal scale	
Y		Number of point used in the vertical coordinate	
YLAB	C	Minimum point in the vertical scale	

TABLE 9. (CONT'D)

Variable Name	C*	Description	Units
ISNO		Snowmelt control integer	
DHMR		Degree-hour melt rate	in/deg-day
TBASE		Snowmelt base temperature	$^{o}_{F}$
WIND		Wind speed	mph
ELEVT		Elevation of basin	1000 ft.
TEMP		Temperature in each time step	$^{o}_{F}$
W12		Percent of impervious area covered by snow	
W13		Water equivalent of snow on W12	in.
W14		Percent of pervious area covered by snow	
W15		Water equivalent of W14	in
W16A		Ratio of free water holding capacity to water equivalent on W12	
W16B		Ratio of free water holding capacity to water equivalent on W14	
W17		Ratio of initial free water to water equivalent	
W18		Manning's 'n' for W12	
W19		Manning's 'n' for W14	
IABLK		DDFACT & QFACT Read in integer	
DDFACT		Dust and dirt loading rates	lbs./100' curb/day
NQS		Number of quality factors being read in	
PNAME		Name of pollutant	
QFACT		Pollutant quality factors	mg/L/S of DS
NACLBS		Lbs. of Chloride applied to sub-area	Lbs.
PBRATE		Lead loading rate	lbs./100' curb/day

TABLE 10. RUNOFF SAMPLE INPUT DATA
(Corresponds to Output in Tables 11 to 18)

```
     RUNOFF
(1)  BANNATYNE SEWER DISTRICT
(1)  MARCH STORM, RAIN WITH SNOW
(2)       1    80   440     5     1                          1
(3)      21   5.0
(4)   0.12 0.12 1.08 1.20 0.96 0.72 0.24 0.36 0.24 0.36
      0.24 0.00 0.12 0.00 0.48 0.12 0.24 0.12 0.00 0.12
(4)   0.00
(4A)             0          30.         10.          .50
(4B)   35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.
       35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.
       35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.
       35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.
(4B)   35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.  35.
(5)            151    1     1     1.25    415.0   0.0193                    0.018
               152   28     1     1.25    570.0   0.0072                    0.018
               153  530     1     1.25    650.0   0.0021                    0.018
               154   38     1     1.25    405.0   0.0039                    0.018
               155   34     1     1.25    825.0   0.0050                    0.018
               156   33     1     1.25    750.0   0.0047                    0.018
               157    4     1     1.25    200.0   0.0155                    0.018
               158   30     1     1.25    975.0   0.0050                    0.018
               159   23     1     1.25    745.0   0.0045                    0.018
               160   26     1     1.25    455.0   0.0068                    0.018
               161  402     1     1.25    380.0   0.0065                    0.018
               162  401     1     1.25    780.0   0.0043                    0.018
               163  513     1     1.25   1270.0   0.0084                    0.018
               164  403     1     1.25    500.0   0.0060                    0.018
               165    6     1     1.25    650.0   0.0124                    0.018
               166    8     1     1.25    665.0   0.0101                    0.018
               167   10     1     1.25   1130.0   0.0067                    0.018
               168  301     1     1.25    895.0   0.0043                    0.018
               169  303     1     1.25   1215.0   0.0035                    0.018
               170   15     1     1.25    110.0   0.0150                    0.018
               171  540     1     1.25    775.0   0.0030                    0.018
               172  203     1     1.25   1103.0   0.0045                    0.018
               173  202     1     1.25   1310.0   0.0037                    0.018
               174  201     1     1.25    600.0   0.0029                    0.018
               175  101     1     1.25    385.0   0.0054                    0.018
               176   40     1     1.25    415.0   0.0031                    0.018
               177   19     1     1.25    415.0   0.0019                    0.018
               178   20     1     1.25    370.0   0.0021                    0.018
               179   22     1     1.25    625.0   0.0034                    0.018
               180  501     1     1.25    615.0   0.0030                    0.018
               181  502     1     1.25    335.0   0.0016                    0.018
               182  503     1     1.25    500.0   0.0024                    0.018
               183  505     1     1.25    800.0   0.0042                    0.018
               184  504     1     1.25    800.0   0.0031                    0.018
               185  601     1     1.25    480.0   0.0057                    0.018
               186   13     1     1.25    180.0   0.0198                    0.018
               187  510     1     1.25    800.0   0.0082                    0.018
               188    9     1     1.25   1070.0   0.0036                    0.018
(5)            189  702     1     1.25    540.0   0.0054                    0.018
```

TABLE 10. (CONT'D)

```
        190   701     1     1.25    775.0   0.0025                    0.018
(5)     191    41     1     1.25   1005.0   0.0020                    0.018
(6)
(7)       1  1513216. 9.2322.430.011
          2  1525272.16.3435.120.006
          3  1532830. 8.7738.440.002
          4  1547457.17.1243.660.004
          5  1559750.14.5530.850.002
          6  1568565.15.7349.430.002
          7  1573517.14.1346.170.002
          8  1584896.17.4256.710.002
          9  1593440.13.0352.690.002
         10  1602724.10.6358.270.002
         11  1612972. 6.1444.900.003
         12  1624816.17.6934.500.002
         13  1634976.19.4230.000.002
         14  1642858. 6.8930.000.002
         15  1651500. 6.1730.000.002
         16  1663040. 9.9530.000.002
         17  1677394.22.4930.000.002
         18  1684384.11.0730.000.002
         19  1697780.23.2230.000.007
         20  1702384. 9.9930.000.002
         21  1713542.20.3375.000.002
         22  1727616.21.3330.000.002
         23  1736423.23.1530.000.002
         24  1742306. 8.4730.000.002
         25  1751660. 5.1430.000.002
         26  1761660. 5.4130.000.002
         27  1771660. 7.2830.000.002
         28  1786464.16.6230.000.002
         29  1792450.14.4130.000.002
         30  1801339.10.7630.000.002
         31  1812291. 6.3130.000.002
         32  1822384.10.4072.230.002
         33  1833300.12.5530.000.004
         34  1843300.12.5830.000.002
         35  1855775.15.9130.000.002
         36  1866053.17.5130.000.002
         37  1871511.11.9030.000.002
         38  1883036.11.1530.000.002
         39  189 742. 7.1330.000.002
         40  1906770.14.9230.000.002
(7)      41  1913895.18.9623.900.002
(8)
(8A)  1  25.  .43  84.  .43   2.   2.   2.
      2  25.  .43  84.  .43   2.   2.   2.
      3  25.  .43  84.  .43   2.   2.   2.
      4  25.  .43  84.  .43   2.   2.   2.
      5  25.  .43  84.  .43   2.   2.   2.
      6  25.  .43  84.  .43   2.   2.   2.
      7  25.  .43  84.  .43   2.   2.   2.
      8  25.  .43  84.  .43   2.   2.   2.
      9  25.  .43  84.  .43   2.   2.   2.
     10  25.  .43  84.  .43   2.   2.   2.
     11  25.  .43  84.  .43   2.   2.   2.
     12  25.  .43  84.  .43   2.   2.   2.
     13  25.  .43  84.  .43   2.   2.   2.
     14  25.  .43  84.  .43   2.   2.   2.
     15  25.  .43  84.  .43   2.   2.   2.
```

TABLE 10. (CONT'D)

16	25.	.43	84.	.43	2.	2.	2.
17	25.	.43	84.	.43	2.	2.	2.
18	25.	.43	84.	.43	2.	2.	2.
19	25.	.43	84.	.43	2.	2.	2.
20	25.	.43	84.	.43	2.	2.	2.
21	25.	.43	84.	.43	2.	2.	2.
22	25.	.43	84.	.43	2.	2.	2.
23	25.	.43	84.	.43	2.	2.	2.
24	25.	.43	84.	.43	2.	2.	2.
25	25.	.43	84.	.43	2.	2.	2.
26	25.	.43	84.	.43	2.	2.	2.
27	25.	.43	84.	.43	2.	2.	2.
28	25.	.43	84.	.43	2.	2.	2.
29	25.	.43	84.	.43	2.	2.	2.
30	25.	.43	84.	.43	2.	2.	2.
31	25.	.43	84.	.43	2.	2.	2.
32	25.	.43	84.	.43	2.	2.	2.
33	25.	.43	84.	.43	2.	2.	2.
34	25.	.43	84.	.43	2.	2.	2.
35	25.	.43	84.	.43	2.	2.	2.
36	25.	.43	84.	.43	2.	2.	2.
37	25.	.43	84.	.43	2.	2.	2.
38	25.	.43	84.	.43	2.	2.	2.
39	25.	.43	84.	.43	2.	2.	2.
40	25.	.43	84.	.43	2.	2.	2.
(8A)41	25.	.43	84.	.43	2.	2.	2.

(9)	6		8		42	1	20	100 1
(11)	1	3	9.0	12.0				
	2	3	16.0	76.0				
	3	3	9.0	53.0				
	4	3	17.0	68.0				
	5	3	15.0	54.8				
	6	3	16.0	81.0				
	7	3	14.0	57.0				
	8	3	17.0	61.0				
	9	3	13-0	70.0				
	10	3	11.0	39.0				
	11	3	6.0	34.0				
	12	3	18.0	68.0				
	13	3	19.0	78.0				
	14	3	7.0	35.0				
	15	3	6.0	26.2				
	16	3	10.0	50.0				
	17	3	22.0	143.0				
	18	1	11.0	58.2				
	19	1	23.0	106.0				
	20	1	10.0	56.0				
	21	1	20.0	57.0				
	22	1	21.0	80.0				
	23	1	23.0	81.0				
	24	1	8.0	42.0				
	25	1	5.0	22.0				
	26	1	5.0	22.0				
	27	1	7.0	24.0				
	28	1	17.0	50.0				
	29	1	14.0	42.0				
	30	1	11.0	37.4				
	31	1	6.0	32.0				
(11)	32	1	10.0	20.0				
	33	1	13.0	45.0				

TABLE 10. (CONT'D)

```
(11)        34      1          13.0        47.0
            35      1          16.0        61.0
            36      1          18.0        53.2
            37      1          12.0        52.0
            38      1          11.0        36.0
            39      3           7.0        24.0
            40      3          15.0        52.0
(11)        41      3          19.0        62.0
(12) 1       1
(13) 1      10     30   402
```

TABLE 11. RAINFALL HISTORY AND TEMPERATURE DATA

BANNATYNE SEWER DISTRICT

MARCH STORM, RAIN WITH SNOW

BASIN NUMBER 1

NUMBER OF TIME STEPS 80

INTEGRATION TIME INTERVAL (MINUTES), 5.00

25.0 PERCENT OF IMPERVIOUS AREA HAS ZERO DETENTION DEPTH

FOR 21 RAINFALL STEPS, THE TIME INTERVAL IS 5.00 MINUTES

FOR RAINGAGE NUMBER 1, RAINFALL HISTORY IS

0.12	0.12	1.08	1.20	0.96	0.72	0.24	0.36	0.24	0.36
0.24	0.0	0.12	0.0	0.48	0.12	0.24	0.12	0.0	0.12
0.0									

DEGREE HOUR MELT RATE = 0.0

TEMPERATURE OF SNOW BASE = 30.0

WIND FACTOR = 0.00500

GAMMA FACTOR = 0.07913

TEMPERATURE AT EACH TIME STEP

35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0

TABLE 12. GUTTER AND PIPE DATA

GUTTER NUMBER		GUTTER CONNECTION	WIDTH (FT)	LENGTH (FT)	SLOPE (FT/FT)	SIDE SLOPES L	R	MANNING N	OVERFLOW (IN)
1	151	1	1.3	415.	0.019	0.0	0.0	0.018	10.00
2	152	28	1.3	570.	0.007	0.0	0.0	0.018	10.00
3	153	530	1.3	650.	0.002	0.0	0.0	0.018	10.00
4	154	38	1.3	805.	0.004	0.0	0.0	0.018	10.00
5	155	34	1.3	825.	0.005	0.0	0.0	0.018	10.00
6	156	33	1.3	750.	0.005	0.0	0.0	0.018	10.00
7	157	4	1.3	200.	0.015	0.0	0.0	0.018	10.00
8	158	30	1.3	975.	0.005	0.0	0.0	0.018	10.00
9	159	23	1.3	745.	0.004	0.0	0.0	0.018	10.00
10	160	26	1.3	455.	0.007	0.0	0.0	0.018	10.00
11	161	402	1.3	380.	0.006	0.0	0.0	0.018	10.00
12	162	401	1.3	780.	0.004	0.0	0.0	0.018	10.00
13	163	513	1.3	1270.	0.008	0.0	0.0	0.018	10.00
14	164	403	1.3	500.	0.006	0.0	0.0	0.018	10.00
15	165	6	1.3	650.	0.012	0.0	0.0	0.018	10.00
16	166	8	1.3	665.	0.010	0.0	0.0	0.018	10.00
17	167	10	1.3	1130.	0.007	0.0	0.0	0.018	10.00
18	168	301	1.3	895.	0.004	0.0	0.0	0.018	10.00
19	169	303	1.3	1215.	0.003	0.0	0.0	0.018	10.00
20	170	15	1.3	110.	0.015	0.0	0.0	0.018	10.00
21	171	540	1.3	775.	0.003	0.0	0.0	0.018	10.00
22	172	203	1.3	1103.	0.004	0.0	0.0	0.018	10.00
23	173	202	1.3	1310.	0.004	0.0	0.0	0.018	10.00
24	174	201	1.3	600.	0.003	0.0	0.0	0.018	10.00
25	175	101	1.3	385.	0.005	0.0	0.0	0.018	10.00
26	176	40	1.3	415.	0.003	0.0	0.0	0.018	10.00
27	177	19	1.3	415.	0.002	0.0	0.0	0.018	10.00
28	178	20	1.3	370.	0.002	0.0	0.0	0.018	10.00
29	179	22	1.3	625.	0.003	0.0	0.0	0.018	10.00
30	180	501	1.3	615.	0.003	0.0	0.0	0.018	10.00
31	181	502	1.3	335.	0.002	0.0	0.0	0.018	10.00
32	182	503	1.3	500.	0.002	0.0	0.0	0.018	10.00
33	183	505	1.3	800.	0.004	0.0	0.0	0.018	10.00
34	184	504	1.3	800.	0.003	0.0	0.0	0.018	10.00
35	185	601	1.3	480.	0.006	0.0	0.0	0.018	10.00
36	186	13	1.3	180.	0.020	0.0	0.0	0.018	10.00
37	187	510	1.3	800.	0.008	0.0	0.0	0.018	10.00
38	188	9	1.3	1070.	0.004	0.0	0.0	0.018	10.00
39	189	702	1.3	540.	0.005	0.0	0.0	0.018	10.00
40	190	701	1.3	775.	0.002	0.0	0.0	0.018	10.00
41	191	41	1.3	1005.	0.002	0.0	0.0	0.018	10.00

TOTAL NUMBER OF GUTTERS/PIPES, 41

ASTERISK (*) DENOTES CIRCULAR PIPE, DIAMETER=WIDTH.

TABLE 13. SUBCATCHMENT DATA

SUBCATCH-MENT NO.	GUTTER OR INLET	WIDTH (FT)	AREA (AC)	PERCENT IMPERV.	SLOPE (FT/FT)	RESISTANCE FACTOR IMPERV.	RESISTANCE FACTOR PERV.	SURFACE STORAGE (IN) IMPERV.	SURFACE STORAGE (IN) PERV.	INFILTRATION RATE (IN/HR) MAXIMUM	INFILTRATION RATE (IN/HR) MINIMUM	DECAY RATE (1/SEC)	GAGE NO.
1	1	151	3216.0	9.2	22.4	0.011	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
2	2	152	5272.0	16.3	35.1	0.006	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
3	3	153	2830.0	8.8	38.4	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
4	4	154	7457.0	17.1	43.7	0.004	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
5	5	155	9750.0	14.5	30.8	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
6	6	156	8565.0	15.7	49.4	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
7	7	157	3517.0	14.1	46.2	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
8	8	158	4896.0	17.4	56.7	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
9	9	159	3440.0	13.0	52.7	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
10	10	160	2724.0	10.6	58.3	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
11	11	161	2972.0	6.1	44.9	0.003	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
12	12	162	4816.0	17.7	34.5	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
13	13	163	4976.0	19.4	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
14	14	164	2858.0	6.9	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
15	15	165	1500.0	6.2	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
16	16	166	3040.0	9.9	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
17	17	167	7394.0	22.5	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
18	18	168	4384.0	11.1	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
19	19	169	7780.0	23.2	30.0	0.007	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
20	20	170	2384.0	10.0	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
21	21	171	3542.0	20.3	75.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
22	22	172	7616.0	21.3	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
23	23	173	6423.0	23.1	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
24	24	174	2306.0	8.5	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
25	25	175	1660.0	5.1	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
26	26	176	1660.0	5.4	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
27	27	177	1660.0	7.3	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
28	28	178	6068.0	16.6	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
29	29	179	2450.0	10.4	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
30	30	180	1339.0	10.8	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
31	31	181	2291.0	6.3	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
32	32	182	2384.0	10.4	72.2	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
33	33	183	3300.0	12.5	30.0	0.004	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
34	34	184	3300.0	12.6	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
35	35	185	5775.0	15.9	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
36	36	186	6053.0	17.5	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
37	37	187	1511.0	11.9	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
38	38	188	3035.0	11.1	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
39	39	189	742.0	7.1	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
40	40	190	6770.0	14.9	30.0	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1
41	41	191	3895.0	19.0	23.9	0.002	0.013	0.250	0.062	0.184	3.00	0.52	0.00115	1

TOTAL NUMBER OF SUBCATCHMENTS, 41

TOTAL TRIBUTARY AREA (ACRES), 542.20

TABLE 14. SNOW DATA

*** SNOW DATA ***

SUBCATCHMENT NO.	PERCENT IMPERV.	W.E. (IN)	PERCENT PERVIOUS	W.E. (IN)	PERCENT IMPERV.	INITIAL F.W. PERV.	PERCENT F.W.H.C.	RESISTANCE FACTOR IMPERV.	RESISTANCE FACTOR PERV.
1	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
2	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
3	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
4	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
5	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
6	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
7	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
8	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
9	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
10	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
11	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
12	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
13	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
14	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
15	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
16	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
17	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
18	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
19	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
20	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
21	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
22	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
23	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
24	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
25	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
26	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
27	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250

TABLE 14. (CONT'D)

28	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
29	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
30	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
31	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
32	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
33	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
34	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
35	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
36	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
37	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
38	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
39	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
40	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250
41	25.0	0.430	84.0	0.430	2.00	2.00	2.00	0.130E-01	0.250

TABLE 15. INPUT QUALITY - LOADING RATES AND ADDITIONAL INFORMATION REGARDING INPUT QUALITY PARAMETERS

```
HYDROGRAPHS WILL BE STORED FOR THE FOLLOWING  41 INLETS

     1   28  530   58   34   33    4   30   23   26
   402  401  513  403    6    8   10  301  303   15
   540  203  202  201  101   40   19   20   22  501
   502  503  505  504  601   13  510    9  702  701
    41

     .....QUALITY SIMULATION INCLUDED IN THIS RUN.....

     INPUT PARAMETERS AS FOLLOWS

     NUMBER OF CONSTITUENTS          8
     NUMBER OF DRY DAYS            8.0
     STREET CLEANING FREQ         42.0 DAYS
     PASSES PER CLEANING             1
     STD CATCHBASIN VOLUME      20.00 FT3
     CATCHBASIN CONTENTS BOD    100.0 MG/L

     METHOD FOR CALCULATING SS:
       SPECIAL TECHNIQUE.
       SAME AS IN ORIGINAL
       RELEASE 1 OF THE SWMM.
       ISS = 1
```

TABLE 16. SUBCATCHMENT QUALITY - DEFINITIONS

WATERSHED QUALITY DEFINITIONS

SUBAREA NUMBER		LAND USE CLASS.	TOTAL GUTTER LENGTH*10**2 FT.	NUMBER OF CATCHBASINS
1	1	3	12.00	9.00
2	2	3	76.00	16.00
3	3	3	53.00	9.00
4	4	3	68.00	17.00
5	5	3	54.80	15.00
6	6	3	81.00	16.00
7	7	3	57.00	14.00
8	8	3	61.00	17.00
9	9	3	70.00	13.00
10	10	3	39.00	11.00
11	11	3	34.00	6.00
12	12	3	68.00	18.00
13	13	3	78.00	19.00
14	14	3	35.00	7.00
15	15	3	26.20	6.00
16	16	3	50.00	10.00
17	17	3	143.00	22.00
18	18	1	58.20	11.00
19	19	1	106.00	23.00
20	20	1	56.00	10.00
21	21	1	57.00	20.00
22	22	1	80.00	21.00
23	23	1	81.00	23.00
24	24	1	42.00	8.00
25	25	1	22.00	5.00
26	26	1	22.00	5.00
27	27	1	24.00	7.00
28	28	1	50.00	17.00
29	29	1	42.00	14.00
30	30	1	37.40	11.00
31	31	1	32.00	6.00
32	32	1	20.00	10.00
33	33	1	45.00	13.00
34	34	1	47.00	13.00
35	35	1	61.00	16.00
36	36	1	53.20	18.00
37	37	1	52.00	12.00
38	38	1	36.00	11.00
39	39	3	24.00	7.00
40	40	3	52.00	15.00
41	41	3	62.00	19.00

TABLE 17. HYDROGRAPH LISTED AND TOTAL FLOW COMPUTATIONS

HYDROGRAPHS WILL BE LISTED FOR THE FOLLOWING 1 GUTTERS OR INLETS

1

TOTAL RAINFALL (CU FT)	0.112149E 07
TOTAL INFILTRATION (CU FT)	0.941019E 06
TOTAL GUTTER FLOW AT INLET (CU FT)	0.405014E 06
TOTAL SURFACE STORAGE AT END OF STORM (CU FT)	0.367582E 05
TOTAL SNOWMELT (CU FT)	0.260037E 06
ERROR IN CONTINUITY, PERCENTAGE OF RAINFALL,	-0.09177

TABLE 18. SUMMARY OF QUANTITY AND QUALITY - RESULTS

BANNATYNE SEWER DISTRICT
MARCH STORM, RAIN WITH SNOW

SUMMARY OF QUANTITY AND QUALITY RESULTS AT LOCATION 1

FLOW IN CFS AND QUALITY IN MG/L (AND COLIF IN MPN/L)

TIME	FLOW	BOD	SUS-S	COLIF	COD	SET-S	NIT	POA	GREASE
A 45.0	0.156E-0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A 50.0	0.135E-0	47.5	18.3	0.847E 06	152.	1.40	1.04	0.119	0.498
A 55.0	0.131	65.9	197.	0.114E 07	184.	1.96	9.17	0.937	0.669
S 0.0	1.32	86.5	0.117E 04	0.113E 07	97.4	5.28	52.8	5.30	0.664
S 5.0	2.47	71.5	0.115E 04	0.106E 07	51.8	7.12	52.3	5.25	0.626
S 10.0	2.00	51.1	908.	0.972E 06	19.7	6.79	43.0	4.31	0.572
S 15.0	1.31	39.3	693.	0.899E 06	22.3	3.65	31.4	3.16	0.529
S 20.0	0.827	29.1	504.	0.868E 06	19.6	3.13	22.9	2.31	0.511
S 25.0	0.592	19.5	313.	0.835E 06	19.3	2.29	14.3	1.45	0.491
S 30.0	0.658	20.3	331.	0.818E 06	18.8	2.42	15.1	1.52	0.481
S 35.0	0.641	19.5	317.	0.796E 06	18.3	2.42	14.5	1.46	0.468
S 40.0	0.499	16.7	263.	0.780E 06	17.9	2.30	12.1	1.22	0.459
S 45.0	0.240	10.7	143.	0.766E 06	17.6	2.05	6.65	0.678	0.451
S 50.0	0.138	6.55	61.5	0.759E 06	17.4	1.98	2.97	0.310	0.447
S 55.0	0.277	9.80	127.	0.751E 06	17.2	2.04	5.93	0.606	0.442
6 0.0	0.549	14.6	225.	0.739E 06	17.0	2.27	10.3	1.05	0.435
6 5.0	0.559	15.2	238.	0.726E 06	16.7	2.31	10.9	1.10	0.427
6 10.0	0.392	11.7	168.	0.710E 06	16.3	2.13	7.76	0.788	0.418
6 15.0	0.296	9.33	122.	0.701E 06	16.1	2.04	5.69	0.581	0.412
6 20.0	0.175	7.07	77.7	0.690E 06	15.9	1.97	3.68	0.380	0.408
6 25.0	0.128	5.37	44.3	0.689E 06	15.8	1.92	2.18	0.230	0.405
6 30.0	0.113	4.99	37.0	0.686E 06	15.7	1.91	1.85	0.196	0.404
6 35.0	0.571E-0	4.38	25.0	0.684E 06	15.7	1.90	1.31	0.142	0.402
6 40.0	0.274E-0	3.97	16.8	0.681E 06	15.6	1.89	0.941	0.106	0.401
6 45.0	0.214E-0	3.70	11.7	0.679E 06	15.6	1.88	0.709	0.825E-01	0.399
6 50.0	0.188E-0	3.58	8.60	0.679E 06	15.6	1.88	0.569	0.685E-01	0.399
6 55.0	0.176E-0	3.45	6.72	0.679E 06	15.6	1.88	0.485	0.601E-01	0.399
7 0.0	0.169E-0	3.39	5.58	0.679E 06	15.6	1.88	0.434	0.549E-01	0.399
7 5.0	0.165E-0	3.36	4.87	0.679E 06	15.6	1.88	0.402	0.517E-01	0.399
7 10.0	0.164E-0	3.32	4.40	0.676E 06	15.5	1.88	0.380	0.495E-01	0.398
7 15.0	0.162E-0	3.29	4.08	0.672E 06	15.4	1.87	0.365	0.479E-01	0.396
7 20.0	0.161E-0	3.27	3.87	0.672E 06	15.4	1.87	0.355	0.469E-01	0.395
7 25.0	0.160E-0	3.27	3.71	0.672E 06	15.4	1.87	0.348	0.462E-01	0.395
7 30.0	0.160E-0	3.26	3.58	0.672E 06	15.4	1.87	0.342	0.457E-01	0.395
7 35.0	0.159E-0	3.26	3.47	0.673E 06	15.4	1.87	0.337	0.452E-01	0.396
7 40.0	0.159E-0	3.25	3.37	0.673E 06	15.4	1.88	0.333	0.447E-01	0.396
7 45.0	0.159E-0	3.25	3.27	0.673E 06	15.4	1.88	0.328	0.443E-01	0.396
7 50.0	0.158E-0	3.25	3.18	0.673E 06	15.4	1.88	0.324	0.439E-01	0.396
7 55.0	0.158E-0	3.24	3.09	0.673E 06	15.4	1.88	0.320	0.435E-01	0.396
8 0.0	0.158E-0	3.24	3.00	0.673E 06	15.4	1.88	0.316	0.431E-01	0.396
8 5.0	0.158E-0	3.23	2.91	0.673E 06	15.4	1.88	0.312	0.427E-01	0.396
8 10.0	0.158E-0	3.22	2.82	0.673E 06	15.4	1.88	0.308	0.423E-01	0.396
8 15.0	0.158E-0	3.22	2.73	0.672E 06	15.4	1.88	0.304	0.419E-01	0.395
8 20.0	0.158E-0	3.21	2.64	0.672E 06	15.4	1.88	0.300	0.414E-01	0.395
8 25.0	0.158E-0	3.21	2.56	0.672E 06	15.4	1.88	0.296	0.410E-01	0.395
8 30.0	0.158E-0	3.20	2.47	0.671E 06	15.4	1.88	0.292	0.406E-01	0.395
8 35.0	0.158E-0	3.20	2.38	0.671E 06	15.4	1.88	0.288	0.402E-01	0.395
8 40.0	0.158E-0	3.19	2.29	0.670E 06	15.4	1.88	0.284	0.398E-01	0.394
8 45.0	0.158E-0	3.18	2.20	0.670E 06	15.4	1.88	0.279	0.394E-01	0.394

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TABLE 18. (CONT'D)

8	50.0	0.158E-0	3.18	2.11	0.670E 06	15.4	1.88	0.275	0.390E-01	0.394
8	55.0	0.158E-0	3.17	2.02	0.669E 06	15.4	1.88	0.271	0.385E-01	0.394
9	0.0	0.158E-0	3.16	1.94	0.669E 06	15.3	1.88	0.267	0.381E-01	0.393
9	5.0	0.158E-0	3.16	1.87	0.668E 06	15.3	1.88	0.264	0.378E-01	0.393
9	10.0	0.157E-0	3.15	1.82	0.668E 06	15.3	1.88	0.262	0.376E-01	0.393
9	15.0	0.157E-0	3.15	1.80	0.668E 06	15.3	1.88	0.261	0.375E-01	0.393
9	20.0	0.157E-0	3.15	1.79	0.667E 06	15.3	1.88	0.260	0.374E-01	0.392
9	25.0	0.157E-0	3.15	1.78	0.667E 06	15.3	1.88	0.260	0.373E-01	0.392
9	30.0	0.157E-0	3.14	1.78	0.666E 06	15.3	1.88	0.259	0.373E-01	0.392
9	35.0	0.157E-0	3.14	1.77	0.666E 06	15.3	1.88	0.259	0.373E-01	0.392
9	40.0	0.157E-0	3.14	1.77	0.665E 06	15.3	1.88	0.259	0.373E-01	0.391
9	45.0	0.157E-0	3.14	1.77	0.665E 06	15.3	1.88	0.259	0.372E-01	0.391
9	50.0	0.157E-0	3.14	1.77	0.665E 06	15.2	1.88	0.259	0.372E-01	0.391
9	55.0	0.157E-0	3.13	1.77	0.664E 06	15.2	1.88	0.259	0.372E-01	0.391
10	0.0	0.157E-0	3.13	1.77	0.664E 06	15.2	1.88	0.259	0.372E-01	0.390
10	5.0	0.157E-0	3.13	1.77	0.663E 06	15.2	1.88	0.258	0.372E-01	0.390
10	10.0	0.157E-0	3.13	1.77	0.663E 06	15.2	1.88	0.258	0.371E-01	0.390
10	15.0	0.157E-0	3.13	1.77	0.662E 06	15.2	1.88	0.258	0.371E-01	0.390
10	20.0	0.157E-0	3.12	1.77	0.662E 06	15.2	1.88	0.258	0.371E-01	0.389
10	25.0	0.157E-0	3.12	1.77	0.662E 06	15.2	1.88	0.258	0.371E-01	0.389
10	30.0	0.157E-0	3.12	1.77	0.661E 06	15.2	1.88	0.258	0.371E-01	0.389
10	35.0	0.157E-0	3.12	1.77	0.661E 06	15.2	1.88	0.258	0.371E-01	0.389
10	40.0	0.157E-0	3.12	1.77	0.660E 06	15.1	1.88	0.258	0.370E-01	0.388
10	45.0	0.157E-0	3.12	1.77	0.660E 06	15.1	1.88	0.258	0.370E-01	0.388
10	50.0	0.157E-0	3.11	1.77	0.660E 06	15.1	1.88	0.258	0.370E-01	0.388
10	55.0	0.157E-0	3.11	1.77	0.659E 06	15.1	1.88	0.257	0.370E-01	0.388
11	0.0	0.157E-0	3.11	1.77	0.659E 06	15.1	1.88	0.257	0.370E-01	0.387
11	5.0	0.157E-0	3.11	1.77	0.658E 06	15.1	1.88	0.257	0.369E-01	0.387
11	10.0	0.157E-0	3.11	1.77	0.658E 06	15.1	1.88	0.257	0.369E-01	0.387
11	15.0	0.157E-0	3.10	1.77	0.657E 06	15.1	1.88	0.257	0.369E-01	0.387
11	20.0	0.157E-0	3.10	1.77	0.657E 06	15.1	1.88	0.257	0.369E-01	0.386

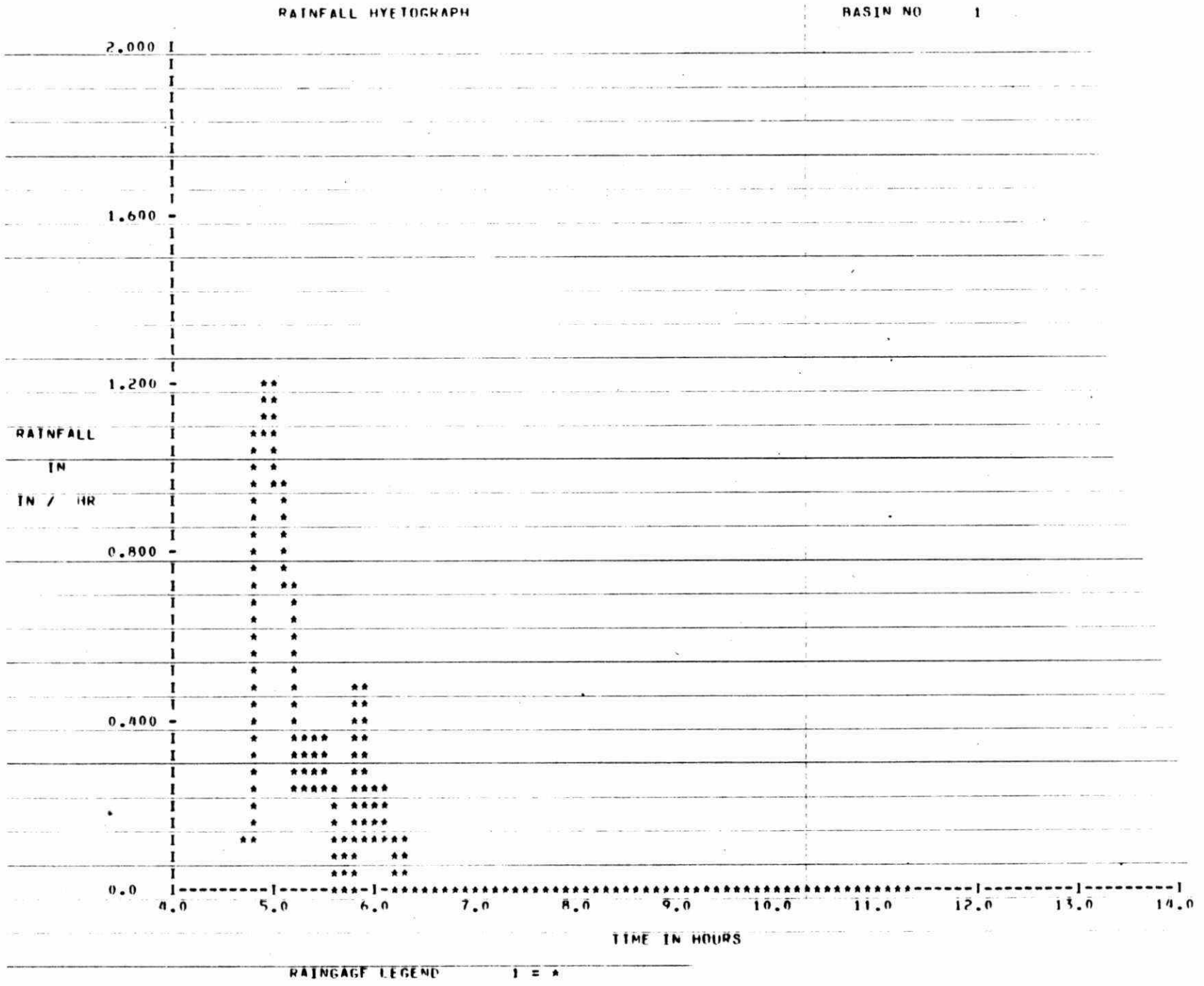

FIGURE 10. RAINFALL HYETOGRAPH

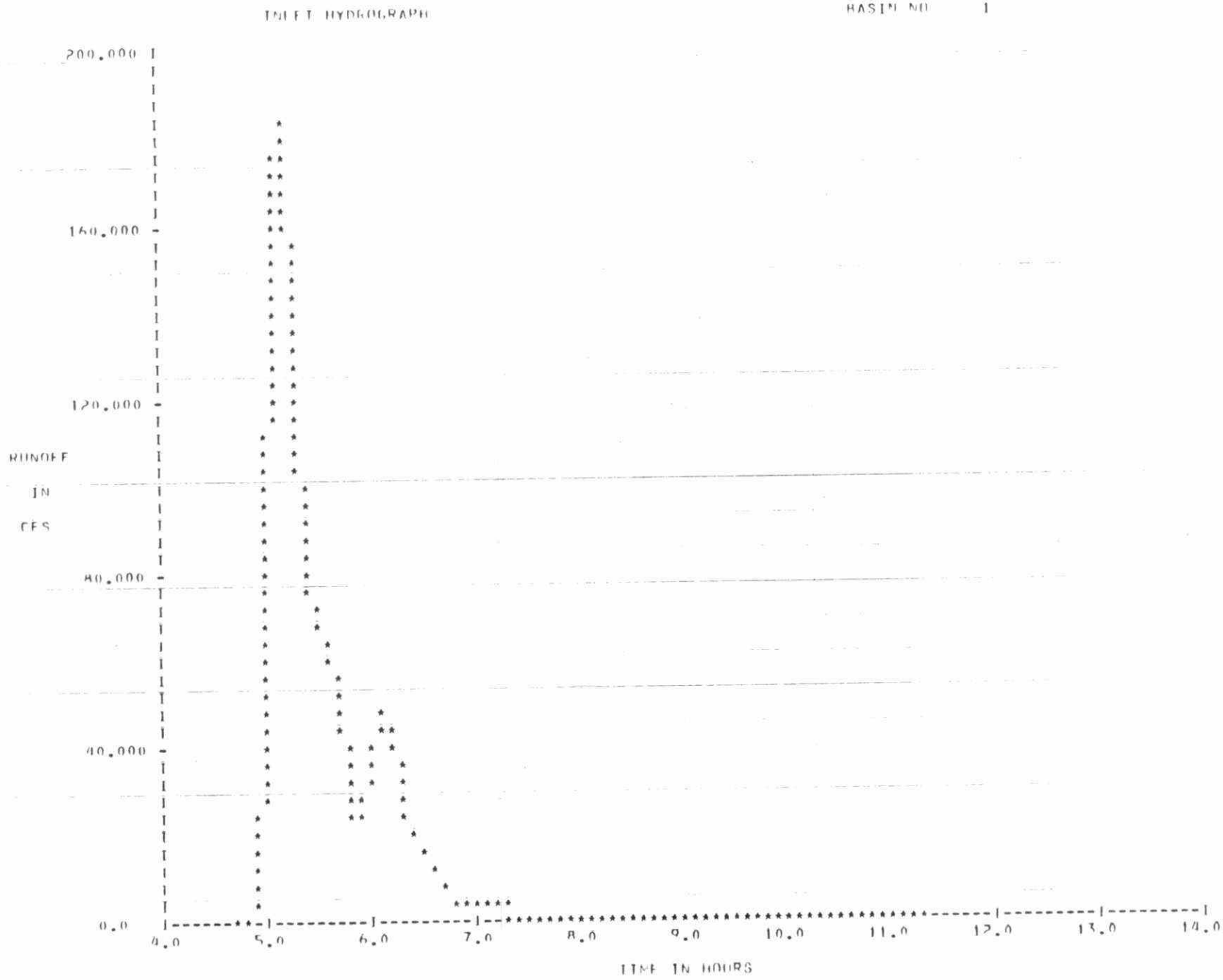

FIGURE 11. INLET HYDROGRAPH

5. TRANSPORT BLOCK

5.1 Introduction

The TRANSPORT Block performs the primary routing computations for both flow and quality parameters. Additional capabilities for computations of dry weather flow, infiltration, and in-line storage effects are also included. Within the framework of the Canadian study, no changes were made to this block other then de-bugging and fix-up changes. The limitations of the TRANSPORT Block were presented in the Volume I, Final Report, and it was recommended that the WRE version of the SWMM be used when surcharging effects are important. Figure 12 shows the relationships between the subroutines of the TRANSPORT Block.

The preparation of input data for the Canadian version is, therefore, identical to that described in the EPA SWMM Version II User's manual. Figure 13 shows the input data set-up and Table 19 shows the coding information. Table 20 defines the variables used in the TRANSPORT Block.

5.2 Example Application

A continuation of the simulation of the Bannatyne area is presented in this section as an example of the application of the TRANSPORT Block. Simulation of the surface runoff, or "inlet" hydrographs was discussed in Section 4.

In this example, both storm water routing and dry weather flow were modelled with the TRANSPORT Block. Infiltration into the sewer network was not modelled. Figure 14 shows the elements of the sewer system which were modelled. The "inlet" manholes shown are the same ones for which "inlet" hydrographs were simulated in the RUNOFF Block.

Table 21 shows the input card data used to operate the TRANSPORT Block. The numbers in parentheses to the left of each line of data refer to the card group number used in Table 19 to describe the data formats.

Table 22 shows the numbering system used by the computer to sequence the elements and computations. "External" numbers are those specified by the user and need not be sequential. "Internal" numbers are assigned by the computer and are sequential. The connectivity of the

system is given by the list of upstream elements for each sewer element. The user may verify this list for correctness. A total of 130 sewer elements were simulated in this example of which 67 were nonconduits. Of the nonconduits, 41 were inlet manholes for which hydrographs were available from the RUNOFF Block. The sewer outfall was located at element 1.

Table 23 shows the input sewer geometry specified by the user. The type of each element is listed along with its slope, length, roughness, diameter, and its computed capacity where appropriate. In this example, both circular and rectangular conduit shapes, and also two proportional flow dividers are modelled.

Table 24 shows the computed dry weather flow from each subcatchment. An average dry weather flow of 5.6 cfs from the entire watershed, and associated BOD, SS, and coliform coefficients were specified. The program apportions dry weather flows to each pipe segment.

Table 25 shows input dry weather flow peaking factors.

Table 26 shows the initial load of solids deposits computed by the program for each conduit.

Table 27 shows the initial flows and concentrations in each conduit prior to simulation.

Tables 28 and 29 show the inlet hydrographs and pollutographs produced by the RUNOFF Block. Note that the hydrograph for external element 1 is the same as that shown on Table 18 in the previous section.

Table 30 shows the load of solids in each conduit after the simulation has been completed.

Tables 31 and 32 show the computed outflow hydrographs and pollutographs in selected pipes. Figure 15 shows the computed outfall hydrograph, and Figures 16 to 18 indicate the associated BOD, SS and coliform pollutographs. These are the basic output results of the TRANSPORT Block.

External element 1 is the outfall, and the computed peak flow was 114 cfs. This outfall hydrograph may be used as input to the STORAGE or RECEIVING WATER Blocks.

Table 33 shows the output of the hydraulic design option within the TRANSPORT Block that re-sizes any conduit in which surcharge conditions are encountered. In this case, conduits 102, 105, 108, 802 and 805 required re-sizing as indicated by an asterisk beside their description.

TABLE 19. TRANSPORT BLOCK CARD DATA

Card group	Format	Card columns	Description	Variable name	Default value
1	16I5	5	Number of sewer cross-sectional shapes, in addition to the 12 program-supplied for which element routing parameters are to follow (maximum value = 3).	NKLASS	0
		10	Control parameter for printing out flow routing parameters for all shapes, *i.e.* KPRINT = 0 to suppress printing, KPRINT = 1 to allow printing (for all shapes, program-supplied and additional)	KPRINT	0
			DELETE CARD GROUPS 2 TO 10 IF NKLASS = 0.		
2			Name of user-supplied shapes.	NAME	
	204A	1-16	16-letter name of shape 1.	NAME(I,14)	None
		17-32	16-letter name of shape 2.	NAME(I,15)	None
3			Number of values of DNORM to be supplied (maximum value = 51, minimum value = 2).	NN	
	16I5	4-5	Number of values for shape 1.	NN(14)	None
		9-10	Number of values for shape 2.	NN(15)	None

NOTE: All non-decimal numbers must be right-justified.
NOTE: Must always specify output tape or disk, two scratch data sets needed.

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
4			Number of values of QNORM to be read (maximum value = 51, minimum value = 2).	MM	
	16I5	4-5	Number of values for shape 1.	MM(14)	None
		9-10	Number of values for shape 2.	MM(15)	None
5			Value of A/A_f [a] corresponding to the maximum Q/Q_f [b] value for each shape.	ALFMAX	
	8F10.5	1-10	A/A_f value for shape 1.	ALFMAX(14)	None
		11-20	A/A_f value for shape 2.	ALFMAX(15)	None
6			Maximum Q/Q_f value for each shape.	PSIMAX	
	8F10.5	1-10	Maximum Q/Q_f value for shape 1.	PSIMAX(14)	None
		11-20	Maximum Q/Q_f value for shape 2.	PSIMAX(15)	None
7			Factor used to determine full flow area for each shape, *i.e.*, for use in AFULL = AFACT(GEOM1)^2.	AFACT	

[a] A/A_f = ANORM is the cross-sectional flow area divided by the cross-sectional flow area of the pipe running full. Tabular values of ANORM are generated in the program by dividing the ANORM axis (0.0 - 1.0) into NN-1 or MM-1 equal divisions.

[b] Q/Q_f = QNORM is the flow rate divided by the flow rate of the conduit flowing full.

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
	8F10.5	1-10	Factor for shape 1.	AFACT(14)	None
		11-20	Factor for shape 2.	AFACT(15)	None
8			Factor used to determine full flow hydraulic radius for each shape, *i.e.*, for use in equation RADH = RFACT(GEOM1).	RFACT	
	8F10.5	1-10	Factor for shape 1.	RFACT(14)	None
		11-20	Factor for shape 2.	RFACT(15)	None
			REPEAT CARD GROUP 9 FOR EACH ADDED SHAPE.		
9			Input of tabular data (depth of flow, y, divided by total depth of conduit, y_f (y/y_f)) for each added shape corresponding to the NN-1 equal divisions of A/A_f of the conduit as given by NN on card group 3.[a]	DNORM	
	8F10.5	1-10	First value for y/y_f for shape 1.	DNORM(I,1)	None
		11-20	Second value for y/y_f for shape .	DNORM(I,2)	None
		.	.	.	
		.	.	.	
		.	.	.	
		.	Last value of y/y_f for shape 1.	DNORM(I,NN(I))	None
			(Total of NN(14)/8 + NN(15)/8 data cards)		

[a] y/y_f = DNORM is the depth of flow, y, divided by the maximum flow depth, y_f (*e.g.*, diameter of a circular conduit).

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
			REPEAT CARD GROUP 10 FOR EACH ADDED SHAPE.		
10			Input of tabular data (flow rate, Q, divided by the flow rate of the conduit running full, Q_f (Q/Q_f)). for each added shape corresponding to the MM-1 equal divisions of A/A_f of the conduit as given by MM on card group 4.	QNORM	
	8F10.5	1-10	First value of Q/Q_f for shape 1.	QNORM(I,1)	None
		11-20	Second value of Q/Q_f for shape 1.	QNORM(I,2)	None
		.	.	.	
		.	.	.	
		.	.	.	
		.	Last value for Q/Q_f for shape 1.	QNORM(I,MM(I))	None
			(Total of MM(14)/8 + MM(15)/8 data cards)		
11	20A4		Title card containing a one-line heading to be printed above output.	TITLE	Blanks
12			Execution control data.		
	16I5	3-5	Total number of sewer elements (maximum = 160).	NE	None
		8-10	Total number of time-steps (maximum = 150).[a]	NDT	None
		14-15	Total number of non-conduit elements into which there will be input hydrographs and pollutographs (maximum = 70, minimum = 1).[a]	NINPUT	None

[a]Not required if input is from tape or disk.

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
		19-20	Total number of non-conduit elements at which input hydrographs and pollutographs are to be printed out (maximum = 20, minimum = 1).	NNYN	None
		24-25	Total number of non-conduit elements at which routed hydrographs and pollutographs are to be printed out (maximum = 20, minimum = 1).	NNPE	None
		30	Total number of non-conduit elements at which flow is to be transferred to a subsequent block by tape or disk (maximum = 5, minimum = 1).[a]	NOUTS	None
		35	Control parameter for program-generated error messages occurring in the execution of the flow routing scheme. These errors do not normally affect the program execution. NPRINT = 0 to suppress messages (recommended), NPRINT = 1 to print messages from ROUTE, NPRINT = 2 to print messages from ROUTE and TRANS.	NPRINT	0
		40	Total number of pollutants being routed (maximum = 4 , minimum = 0)[b]. When NPOLL = 0, program will route flows only and all quality operations will be bypassed.	NPOLL	0
		45	Total number of iterations to be used in routing subroutine (4 recommended).	NITER	4

[a] These are the only points that can be plotted by subroutine GRAPH after being routed by TRANSPORT.

[b] The three pollutants ordinarily routed are BOD, SS and coliforms. A fourth conservative pollutant may be routed if provided for on input tapes, but internal storage should not be used in this case. Not required if input is from tape or disk.

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
13			Execution control data.		
	8F10.5	1-10	Size of time-step for computation, sec.[a]	DT	None
		11-20	Allowable error for convergence of iterative methods in routing routine (0.0001 recommended).	EPSIL	0.0001
		21-30	Total number of days (dry weather days) prior to simulation during which solids were not flushed from the sewers.	DWDAYS	0
14			Execution control data.		
	1615	5	Control parameter specifying means to be used in transferring inlet hydrographs, *i.e.*, NCNTRL = 0, normal transfer by tape or disk, NCNTRL = 1, input from cards, utilizing card groups 28, 46 and 47.	NCNTRL	0
		10	Control parameter in estimating groundwater infiltration inflows, *i.e.*, NINFIL = 0, infiltration not estimated (INFIL not called and corresponding data omitted), NINFIL = 1, infiltration to be estimated (subroutine INFIL called).	NINFIL	0
		15	Control parameter in estimating sanitary sewage inflow, *i.e.*, NFILTH = 0, sewage inflows not estimated (FILTH not called and corresponding data omitted),	NFILTH	0

[a] should agree with time-step used in RUNOFF for input from tape or disc

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
			NFILTH = 1, sewage inflows to be estimated (subroutine FILTH called).		
		20	Control parameter concerning printed output, *i.e.*,	JPRINT	0
			JPRINT = 0, flows and concentration not printed,		
			JPRINT = 1, flows and concentrations printed out in tabular form.		
		25	Control parameter concerning plotting of output,	JPLOT	0
			JPLOT = 0, plotting routine *not* called from within TRANSPORT,		
			JPLOT = 1, plotting routine *is* called from within TRANSPORT.[a]		
		30	Control parameter for hydraulic design routine, *i.e.*,	NDESN	0
			NDESN = 0, hydraulic design routine is not called,		
			NDESN = 1, hydraulic design routine is to be called.		
			REPEAT CARD GROUP 15 FOR EACH NUMBERED SEWER ELEMENT (maximum number of cards = 160). THESE CARDS MAY BE READ IN ANY ORDER.		
15			Sewer element data.		
	5I4	1-4	External element number.[b] No element may be labeled with a number greater than 1000, and it must be a positive numeral.	NOE	None

[a] Not operational.

[b] "External" numbers are those assigned by the user to the various sewer system components. "Internal" numbers are assigned within the program. All input to the Transport Model is in terms of external numbers.

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
			However, numbering need not be consecutive or continuous.		
		******	EXTERNAL NUMBER(S) OF UPSTREAM ELEMENT(S). UP TO THREE ARE ALLOWED. A ZERO DENOTES NO UPSTREAM ELEMENT (maximum value = 1000). ******		
		5-8	First of three possible upstream elements.	NUE(1)	None
		9-12	Second of three possible upstream elements.	NUE(2)	None
		13-16	Third of three possible elements.	NUE(3)	None
		17-20	Classification of element type. Obtain value from Table 6-1.	NTYPE	16
		******	THE FOLLOWING VARIABLES ARE DEFINED BELOW FOR CONDUITS ONLY. REFER TO TABLE 6-1 FOR REQUIRED INPUT FOR NON-CONDUITS. * ******		
	7F8.3	21-28	Element length for conduit, ft.	DIST	None
		29-36	First characteristic dimension of conduit, ft. See Figure 6-4 and Table 6-2 for definition.*	GEOM1	None
		37-44	Invert slope of conduit, ft/100 ft.	SLOPE	0.1
		45-52	Manning's roughness of conduit.	ROUGH	0.013
		53-60	Second characteristic dimension of conduit, ft. See Figure 6-4 and Table 6-2 for definition.* (Not required for some conduit shapes.)	GEOM2	None
		61-68	Number of barrels[a] for this element. The barrels are assumed to be identical in shape and flow characteristics. (Must be integer $\geq$ 1.)	BARREL	1.0

[a]Example: A two barrelled conduit would consist of two identical parallel conduits adjacent to each other.

*Refer to U.S. EPA Version II User's Manual.

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
		69-76	Third characteristic dimension of conduit, ft. See Figure 6-4 and Table 6-2 for definition.* (Not required for some conduit shapes.)	GEOM3	None
			CARDS 16 THROUGH 26 ARE DATA INPUT FOR INTERNAL STORAGE. (NTYPE = 19). OMIT THESE DATA CARDS IF INTERNAL IS NOT DESIRED.		
			REPEAT STORAGE MODEL DATA FOR EACH STORAGE ELEMENT (maximum = 2).		
16			Storage unit data card.		
	10I5	1-5	Storage mode parameter.[a]	ISTMOD	1
			= 1 in-line storage.		
		6-10	Storage type parameter.	ISTTYP	1
			= 1 irregular (natural) reservoir,		
			= 3 geometric (regular) uncovered reservoir.		
		11-15	Storage outlet control parameter.	ISTOUT	1
			= 1 gravity with orifice center line at zero storage tank depth,		
			= 2 gravity with fixed weir,		
			= 6 existing fixed-rate pumps,		
			= 9 gravity with both weir and orifice.		

[a]Must be set equal to one since other storage mode parameters are not programmed.

*Refer to U.S. EPA Version II User's Manual.

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
17			Computation/print control card.		
	3I10	1-10	Pollutant parameter.	IPOL	0
			= 0 no pollutants (hydraulics only),		
			= 1 perfect plug flow through basin,		
			= 2 perfect mixing in basin.		
		11-20	Print control parameter.	IPRINT	0
			= 0 no print each time-step,		
			= 1 print each time-step in storage.		
		21-30	Cost computation parameter.	ICOST	0
			= 0 no cost computations,		
			= 1 costs to be computed.		
18			Reservoir flood depth data card.		
	F10.2	1-10	Maximum (flooding) reservoir depth, ft.	DEPMAX	None
			INCLUDE EITHER CARD GROUP 19 OR 20, NOT BOTH.		
			INCLUDE CARD GROUP 19 ONLY IF ISTTYP ON CARD 16 HAS THE VALUE 1.		
19			Reservoir depth-area data card.		
	F10.2	1-10	A reservoir water depth, ft.	ADEPTH(1)	None
	F10.0	11-20	Reservoir surface area corresponding to above depth, ft^2.	AASURF(2)	None
	F10.2	61-70	A reservoir water depth, ft.	ADEPTH(4)	None

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
	F10.0	71-80	Reservoir surface area corresponding to above depth, ft^2.	AASURF(4)	None
			(NOTE: The above pair of variables is repeated 11 times, 4 pairs per card.)		
			INCLUDE CARD 20 ONLY IF ISTTYP ON CARD 16 HAS THE VALUE 3.		
20			Reservoir dimensions data card. Reservoir has shape of inverted truncated cone.		
	2F10.0	1-10	Reservoir base area, ft^2.	BASEA	None
		11-20	Reservoir base circumference, ft.	BASEC	None
	F10.5	21-30	Cotan of sideslope (horizontal/vertical).	COTSLO	None
			INCLUDE ONLY ONE OF THE OUTLET DATA CARDS 21, 22, 23 or 24.		
			INCLUDE CARD 21 ONLY IF ISTOUT ON CARD 16 HAS THE VALUE 1.		
21			Orifice outlet data card.		
	F10.3	1-10	Orifice outlet area x discharge coefficient, ft^2.	CDAOUT	None
			INCLUDE CARD 22 ONLY IF ISTOUT ON CARD 16 HAS THE VALUE 2.		
22			Weir outlet data card.		
	2F10.3	1-10	Weir height (ft) above depth = 0.	WEIRHT	None
		11-20	Weir length, ft.	WEIRL	None

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
			INCLUDE CARD 23 ONLY IF ISTOUT ON CARD 16 HAS THE VALUE 6.		
23			Pump outlet data card.		
	3F10.3	1-10	Outflow pumping rate, cfs.	QPUMP	None
		11-20	Depth (ft) at pump startup.	DSTART	None
		21-30	Depth (ft) at pump shutdown (DSTOP > 0.0).[a]	DSTOP	None
			INCLUDE CARD 24 ONLY IF ISTOUT HAS THE VALUE 9.		
24			Weir and orifice outlet data card.		
	8F10.5	1-10	Weir height above depth = 0, ft.	WEIRHT	None
		11-20	Weir length, ft.	WEIRL	None
		21-30	Orifice outlet area x discharge coefficient, ft^2.	CDAOUT	None
		31-40	Orifice centerline elevation above zero depth, ft.	ORIFHT	None
25			Initial conditions data card.		
	2F10.2	1-10	Storage (ft^3) at time zero.	STORO	None
		11-20	Outflow rate (cfs) at time zero.	QOUTO	None
			CARD 26 MUST BE INCLUDED: IT MAY BE BLANK IF ICOST ON CARD 17 HAS THE VALUE 0.		
26			Cost data card.		

[a] DSTOP must equal or be greater than the level in storage that contains enough volume to handle the pumping rate, QPUMP, for one time-step.

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
	F10.2	1-10	$/yard^3 for storage excavation.	CPCUYD	None
	2F10.0	11-20	$/acre for storage land.	CPACRE	None
		21-30	$/pump station with related structures.	CPS	None
27			List of external non-conduit element numbers at which outflows are to be transferred to subsequent blocks for a total of NOUTS (card 12) non-conduit elements.	JN	
	16I5	1-5	First element number.[a]	JN(1)	None
		6-10	Second element number.[a]	JN(2)	None
		.			
		.			
		.			
		.			
		.	Last element number.[a]	JN(NOUTS)	None
			IF NCNTRL = 0 ON CARD 14, SKIP TO CARD GROUP 29.		
28			Non-conduit element numbers into which hydrographs and pollutographs (from card input) enter the sewer system. These must be in the order in which hydrograph and pollutograph ordinates appear at each time step.		
	16I5	1-5	First element number.	NORDER(1)	None
		6-10	Second element number.	NORDER(2)	None
		.			
		.			
		.			
		.			
		.	Last element number.	NORDER(NINPUT)	None

[a]Element numbers transferred to subsequent blocks must be numbered less than or equal to 100.

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
29			List of external non-conduit element numbers at which input hydrographs and pollutographs are to be stored and printed out for a total of NNYN (card 12) non-conduit elements.	NYN	
	16I5	1-5	First input location number.	NYN(1)	None
		6-10	Second input location number.	NYN(2)	None
		.		.	
		.		.	
		.		.	
		.		.	
		.	Last input location number.	NYN(NNYN)	None
30			List of external non-conduit element numbers at which output hydrographs and pollutographs are to be stored and printed out for a total of NNPE (card 12) non-conduit elements.	NPE	
	16I5	1-5	First output location number.	NPE(1)	None
		6-10	Second output location number.	NPE(2)	None
		.		.	
		.		.	
		.		.	
		.	Last output location number.	NPE(NNPE)	None
			IF SUBROUTINE INFIL IS TO BE CALLED (NINFIL = 1), INSERT CARDS 31 THROUGH 33 OTHERWISE OMIT.		
31			Estimated infiltration.		
	10F8.1	1-8	Base dry weather infiltration, gal/min.	DINFIL	0.0
		9-16	Groundwater infiltration, gal/min.	GINFIL	0.0
		17-24	Rainwater infiltration, gal/min.	RINFIL	0.0

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
32			Control parameters.		
	I5	3-5	Day of year of estimate.[a]	NDYUD	None
	6F8.1	6-13	Peak residual moisture, gal/min.	RSMAX	0.0
		14-21	Average distance between joints, ft.	ULEN	6.0
33			Monthly degree-days.[b]	NDD	
	16I5	1-5	July degree-days.	NDD(1)	None
		6-10	August degree-days.	NDD(2)	None
		.		.	.
		.		.	.
		.		.	.
		56-60	June degree-days.	NDD(12)	None
			IF SUBROUTINE FILTH IS TO BE CALLED (INFILTH = 1), INSERT CARD GROUPS 34 THROUGH 45, OTHERWISE OMIT.		
34			Factors to correct yearly average sewage flows to daily average by accounting for daily variations throughout a typical week.		
	7F10.0	1-10	Flow correction for Sunday.	DVDWF(1)	1.0
		11-20	Flow correction for Monday.	DVDWF(2)	1.0
		.		.	
		.		.	
		.		.	
		61-70	Flow correction for Saturday.	DVDWF(7)	1.0

[a]Day one is July 15.

[b]See Table A-1 in U.S. EPA Version II User's Manual.

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
			IF NPOLL = 0 SKIP TO CARD GROUP 37		
35			Factors to correct BOD yearly averages to daily averages.		
	7F10.0	1-10	BOD correction for Sunday.	DVBOD(1)	1.0
		.			.
		.			.
		.			.
		.			.
		61-70	BOD correction for Saturday.	DVBOD(7)	1.0
36			Factors for correction of yearly SS averages to daily averages.		
	7F10.0	1-10	SS correction for Sunday.	DVSS(1)	1.0
		.			.
		.			.
		.			.
		.			.
		61-70	SS correction for Saturday.	DVSS(7)	1.0
37			Factors to correct daily average sewage flow to hourly averages by accounting for hourly variations throughout a typical day (3 cards needed).		
	8F10.0	1-10	Midnight to 1 a.m. factor (first card).	HVDWF(1)	1.0
		.			.
		.			.
		.			.
		.			.
		1-10	8 a.m. to 9 a.m. factor (second card).	HVDWF(9)	1.0
		.			.
		.			.
		.			.
		.			.
		1-10	4 p.m. to 5 p.m. factor (third card).	HVDWF(17)	1.0

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
			IF NPOLL = 0 SKIP TO CARD GROUP 41		
38			Factors for BOD hourly corrections (3 cards needed).		
	8F10.0	1-10	Midnight to 1 a.m. factor (first card).	HVBOD(1)	1.0
		.			.
		.			.
		.			.
		.			.
		71-80	11 a.m. to midnight factor (third card).	HVBOD(24)	1.0
39			Factors for SS hourly corrections (3 cards needed).		
	8F10.0	1-10	Midnight to 1 a.m. factor (first card).	HVSS(1)	1.0
		.			.
		.			.
		.			.
		.			.
		71-80	11 a.m. to midnight factor (third card).	HVSS(24)	1.0
			INCLUDE ONLY WHEN 3 POLLUTANTS ARE SPECIFIED.		
40			Factors for E. coli hourly corrections (3 cards needed).		
	8F10.0	1-10	Midnight to 1 a.m. factor (first card).	HVCOLI(1)	1.0
		.			.
		.			.
		.			.
		.			.
		71-80	11 a.m. to midnight factor (third card).	HVCOLI(24)	1.0
41			Study area data.		
	6I5	1-5	Total number of subareas within a given study area in which sewage flow and quality are to estimated.	KTNUM	None
		6-10	Indicator as to whether study area data, such as treatment plant records, are to be used to estimate sewage quality, *i.e.*,	KASE	1

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
			KASE = 1, yes,		
			KASE = 2, no.		
		11-15	Total number of process flows within the study area for which data are included in one of the following card groups.	NPF	0
		16-20	Number indicating the day of the week during which simulation begins (Sunday = 1).	KDAY	1
		21-25	Number indicating the hour of the day during which simulation begins (1 a.m. = 1).	KHOUR	0
		26-30	Number indicating the minute of the hour during which simulation begins.	KMINS	0
	2F5.1	31-35	Consumer Price Index.	CPI	109.5
		36-40	Composite Construction Cost Index.	CCCI	103.0
	F10.3	41-50	Total population in all areas, thousands.	POPULA	None
			IF KASE = 1, INCLUDE CARD GROUPS 42, 43 and 44.		
42			Average study area data.		
	3F10.0	1-10	Total study area average sewage flow, i.e., from treatment plant records, cfs.[a]	ADWF	0.0
		11-20	Total study area average BOD, mg/l.	ABOD	0.0
		21-30	Total study area average SS, mg/l.	ASUSO	0.0
	E10.2	31-40	Total coliforms, MPN/100 ml.	ACOCI	0.0

[a] If ADWF = 0.0, then total BOD, SS, and COLI will = 0.0. Predicted DWF out downstream end of system will be adjusted to this value.

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
43			Categorized study area data.		
	8F8.0	1-8	Total study area from which ABOD and ASUSO were taken, acres.	TOTA	None
		9-16	Total contributing industrial area, acres.	TINA	None
		17-24	Total contributing commercial area, acres.	TCA	None
		25-32	Total contributing high income (above $15,000) residential area, acres.	TRHA	None
		33-40	Total contributing average income (above $7,000 but below $15,000) residential area, acres.	TRAA	None
		41-48	Total contributing low income (below $4,000) residential area, acres.	TRLA	None
		49-56	Total area from the above three residential areas that contribute additional waste from garbage grinders, acres.	TRGGA	None
		57-64	Total park and open area within the study area, acres.	TPOA	None
			IF PROCESS FLOW DATA ARE AVAILABLE (NPF NOT EQUAL 0 AND KASE = 1), REPEAT CARD GROUP 44 FOR EACH PROCESS FLOW. OTHERWISE, SKIP TO CARD GROUP 45.		
44			Process flow characteristics.		
	15	1-5	External manhole number into which flow is assumed to enter (maximum value = 1000, minimum value = 1).	INPUT	None
	6F10.3	6-15	Average daily process flow entering the study area system, cfs.	QPF	None
		16-25	Average daily BOD of process flow, mg/l.	BODPF	0.0
		26-35	Average daily SS of process flow, mg/l.	SUSPF	0.0

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
			REPEAT CARD GROUP 45 FOR EACH OF THE KTNUM SUBAREAS. THESE SUBAREAS DO NOT NECESSARILY HAVE TO CORRESPOND TO RUNOFF SUBCATCHMENTS.		
45			Subarea data.		
	2I3	1-3	Subarea number.	KNUM	None
		4-6	External number of the manhole into which flow is assumed to enter for subarea KNUM (maximum value = 1000, minimum value = 1).	INPUT	None
	3I1	7	Predominant land use within subarea, *i.e.*,	KLAND	5
			KLAND = 1, Single-family residential,		
			KLAND = 2, Multi-family residential,		
			KLAND = 3, Commercial,		
			KLAND = 4, Industrial,		
			KLAND = 5, Undeveloped or park lands.		
		8	Parameter indicating whether or not water usage within subarea KNUM is metered.	METHOD	2
			METHOD = 1, metered water use,		
			METHOD = 2, incomplete or no metering.		
		9	Parameter indicating units in which water usage estimates (WATER) are tabulated.	KUNIT	0
			KUNIT = 0, thousand gal/mo,		
			KUNIT = 1, thousand ft^3/mo.		

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
	13F5.1	10-14	Measured winter water use for subarea KNUM in the unts specified by KUNIT (not required).	WATER	None
		15-19	Cost of the last thousand gal. of water per billing period for an average consumer within subarea KNUM, cents/1,000 gal. (not required).	PRICE	None
		20-24	Measured average sewage flow from the entire subarea KNUM, cfs (not required).	SEWAGE	None
		25-29	Total area within subarea KNUM, acres (maximum = 200).	ASUB	None
		30-34	[a]Population density within subarea KNUM, population/acres.	POPDEN	None
		35-39	[a]Total number of dwelling units within subarea KNUM.	DWLINGS	10.0/ac.
		40-44	[a]Number of people living in average dwelling unit within subarea KNUM.	FAMILY	3.0
		45-49	[a]Market value of average dwelling unit within subarea KNUM, thousands of dollars.	VALUE	20.0
		50-54	[a]Percentage of dwelling units possessing garbage grinders within subarea KNUM.	PCGG	None
		55-59	Total industrial process flow originating within subarea KNUM, cfs.[b]	SAQPF	0.0
		60-64	BOD contributed from industrial process flow originating within subarea KNUM, mg/l.	SABPF	0.0
		65-69	SS contributed from industrial process flow originating within subarea KNUM, mg/l.	SASPF	0.0
		70-74	Income of average family living within subarea KNUM.	XINCOM	VALUE/2.5

[a]Not required if KLAND greater than 2.

[b]If SAQPF = 0.0, then DWBOD and DWSS will be zero for land use 4 (i.e., for industrial flow to be considered KLAND must equal 4).

TABLE 19. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
	12	75-76	MSUBT = 0, subtotals not made, MSUBT = 1, subtotal made. END OF FILTH DATA CARDS.	MSUBT	0
			IF NCNTRL = 0 ON CARD 14, SKIP CARDS 46 and 47.		
46			Time for start of storm.		
	F10.0	1-10	Time of day of start of storm, sec.	TZERO	0.0
			REPEAT CARD 47 FOR EACH INLET FOR FIRST TIME STEP AND THEN REPEAT CARD 47 FOR EACH INLET FOR SECOND TIME STEP, ETC. REPEAT THIS COMBINATION UNTIL ALL TIME STEPS HAVE BEEN READ.[a]		
47			Hydrograph and pollutograph input cards.		
	4F10.0	1-10	Input flow for this time step at first inlet, cfs.	RNOFF(1)	0.0
		11-20	Input BOD for this time step at first inlet, lbs/min.	PLUTO(1,1)	0.0
		21-30	Input SS for this time step at first inlet, lbs/min.	PLUTO(1,2)	0.0
		31-40	Input coliform for this time step at first inlet, MPN/min.	PLUTO(1,3)	0.0
		41-80	Not used.		
			FOR GRAPHING TRANSPORT OUTPUT, CALL GRAPH SUBROUTINE THROUGH THE EXECUTIVE BLOCK. END OF TRANSPORT BLOCK DATA CARDS.		

[a]Note: Order of inlets must be the same as indicated in card group 28.

TABLE 20. TRANSPORT BLOCK VARIABLES[a]

Variable Name	C*	Description	Units
A	C	Cross-sectional areas of flow	sq ft
AA		Cross-sectional areas of flow	sq ft
AAA	C	Flow depth computational variable	
AASURF		Surface area (data array member)	sq ft
AB		Area computational variable	
ABOD		Average BOD concentration measured in sewer or at treatment facility	mg/L
ACOLI		Total coliforms	MPN/100 ml
ADEPTH		Depth (data array member)	ft
ADWF		Average measured DWF	cfs
AF		Cross-sectional area of conduit	sq ft
AFACT	C	Factor to calculate AFULL	
AFULL	C	Full flow area for conduits	sq ft
AINFIL		Total infiltration within drainage basin	cfs
ALF	C	Value of A/A_f corresponding to Q/Q_f value	
ALFMAX	C	Value of A/A_f corresponding to maximum Q/Q_f value	
ALM		Computational variable associated with conduit area	
ALPHA		Normalized area flow, A/A_f	
ANORM	C	Normalized depths, D/D_f, corresponding to A/A_f	
AO2DT2		Routing parameter (data array member)	
APLAN	C	Land area requirement	sq ft
AQQ		Average computed infiltration	cfs
AREAF		Flow area of given flow rate in conduit	sq ft
ARG		Cotangent of angle which is formed from radius and wetted surface	
ASUB		Total area within subarea KNUM	acres
ASUSD		Average SS concentration measured in sewer or at treatment facility	mg/l
ATERM	C	Variable used to calculate area of a conduit, area flow/area full	
A1		Normalized depth of conduit upstream, A/A_f	ft
A1BOD		Average weighted BOD	lb/day/cfs
A1COLI		Average number of coliform bacteria	MPN/day/cfs
A1SS		Average weighted SS	lb/day/cfs
A2		Normalized depth of conduit downstream, A/A_f	ft
BARREL	C	Total number of barrels in each conduit	
BASEA		Base area (geometric basin)	sq ft
BASEC		Base circumference (geometric basin)	ft
BDEPTH	C	Depth (array member)	ft
BLANK	C	Supercritical flow indicator	
BODCON		Computed BOD concentration	mg/L
BODCOT		BOD outflow concentration	mg/L
BODIN	C	BOD input to storage element	lb/DT
BODOUT	C	BOD output from storage element	lb/DT
BODPF		Average BOD of a process flow	mg/L
BSTOR	C	Maximum storage capacity of storage element	cf

[a]Does not include variables added during updating.

C* = Variable names shared in common blocks.

TABLE 20. (CONT'D)

Variable Name	C*	Description	Units
CATH	C	Flow depth computation variable	
CATHY		Flow depth variable used in computing the hydraulic radius	
CCCI		Composite construction cost index	
CDAOUT		Orifice area x discharge coefficient	sq ft
CF		Correction factor for weight sewage strength	
CF2		Correction factor for DWF	
CLAND	C	Cost of land	$
COSTSLO		Basin sideslope cost [illegible]	$/ft
CPACRE	C	Unit cost of land	$/ac
CPCUYD	C	Unit cost of excavation	$/cy
CPI		Consumer Price Index	
CPOLL	C	Pollutant concentrations	mg/l
CPS	C	Pumping station and structure cost	$
CRITD		Critical settling diameter of particles undergoing deposition in conduits	ft
CSTOR	C	Cost of excavation for storage	$
CTOTAL	C	Total cost	$
CUMIN		Cumulative water inflow	cf
CUMOUT	C	Cumulative water outflow	cf
C1	C	Flow routing variable	variable
C1BOD		Computed BOD total after deducting process flows	lb/day
C1DT		Time-step	days
C1DWF		Total DWF less infiltration	cfs
C11		Normalized flow-area computational variable	
C2		Negative value of normalized flow rate	
C2BOD		Computed BOD total further corrected for weighting effects	lb/day
C2DWF		C1DWF less process flows	cfs
C2SS		Weighted SS strengths according to subarea	lb/day
D		Computational variable used in subroutine NEWTON	
DALPHA		Increment for normalized area data	
DD		Wetted depth of the modified element cross section area, i.e., basket-handle conduit and rectangular with triangular bottom	
DDEPTH		Depth increment	ft
DDWF		Daily subarea sewage contribution, A.WF	cfs
DELQ		Incremental discharge of the flows between each time step	cfs
DEPMAX	C	Maximum flood depth of reservoir	ft
DEPTH		Water depth of reservoir	ft
DEPTHL		Depth of reservoir for the previous time step	ft
DETENT	C	Reservoir plug flow detention time	sec
DH		Computation variable used in determining the flow over a flow divider	
DIAM		Diameter of circular pipe	ft

TABLE 20. (CONT'D)

Variable Name	C*	Description	Units
DINFIL		Dry weather infiltration	gpm
DIST	C	Conduit length	ft
DNORM	C	Normalized depths of flow	
DPSI		Derivative of Q/Q_f with respect to A/A_f	
DPSI		Name of subroutine	
DSTART	C	Depth at the pump startup	ft
DSTOP	C	Depth at pump shutdown	ft
DT	C	Size of time-step	sec
DTIM		Time on input tape from RUNOFF	sec
DTMORE	C	Extra time-step needed to pump dry	
DTON	C	Number of time-steps pumped	
DTPUMP	C	Total time-steps to pump dry	
DUMDEP	C	Dummy depth used in internal storage reservoir calculations	ft
DUMSTR	C	Dummy storage volume used in internal storage reservoir calculations	cf
DUMY1		Corrected hourly DWF	cfs
DUMY2		Corrected hourly BOD concentration	lb/sec
DUMY3		Corrected hourly SS concentration	lb/sec
DUMY4		Corrected hourly concentration of fourth pollutant	(not yet programmed)
DUMY5		Corrected hourly coliform concentration	MPN/sec
DV		The change in flow velocity between two succeeding flow routing iterations	
DVBOD	C	Daily BOD variation factor	
DVDWF	C	Daily sewage flow variation factor	
DVSS	C	Daily SS variation factor	
DWBOD		BOD of DWF of each subarea	lb/sec/DT
DWCOLI		Coliform load of DWF in each subarea	MPN/100 mL
DWDAYS		Total number of antecedent dry days	days
DWF		Dry weather flow	cfs
DWLNGS		Total number of dwelling units within subarea KNUM	
DWLOAD		Name of subroutine	
DWSS		SS of DWF in each subarea	lb/sec/DT
DW1BOD		DWF BOD in each subarea for each time-step	lb/DT
DW1SS		DWF SS in each subarea for each time-step	lb/DT
DXDT	C	Length of conduit divided by time-step interval in seconds	ft/sec
D1	C	Perimeter of rectangular, round bottom conduit	ft
D1		Rate constant for decay	1/day
D2	C	Wetted perimeter of rectangular, round bottom conduit	ft
D2		Rate constant for reaeration	1/day
D2COLI		Total DWF coliform per subarea	MPN/sec
EPSIL	C	Allowable error for convergence in routing routine	
FAMILY		Number of people living in average dwelling unit within subarea KNUM	
FILTH		Name of subroutine	
FINDA		Name of subroutine	

TABLE 20. (CONT'D)

Variable Name	C*	Description	Units
FIRST		Name of subroutine	
FON		Fraction of time-step pumped	
FRAC	C	Fraction of an inflow plug	
GEOM1	C	Conduit vertical dimension	ft
GEOM2	C	Conduit horizontal dimension	ft
GEOM3	C	Conduit dimension	ft
GINFIL		Groundwater infiltration	gpm
GNO	C	Supercritical flow indicator, flow not supercritical	
H		Head over weir	ft
HELP		Normalized area flow (= ALPHA)	
HVBOD	C	Hourly BOD variation factor	
HVCOLI	C	Hourly coliform variation factor in DWF	
HVDWF	C	Hourly sewage flow variation factor	
HVSS	C	Hourly SS variation factor	
I		Dimension and do loop counter	
I		Ratio of A/ΔA for linear interpolation counter (DPSI, PSI)	
ICHK		Newton-Raphson iteration check	
ICOST	C	Cost output control parameter	
IFLOOD	C	Flood Indicator	
II		Do loop counters	
III		Do loop counters	
IK		Do loop counter for element number	
INCNT	C	Counting parameter for I/O input files	
INFIL		Name of subroutine	
INITAL	XP	Name of subroutine	
INPUT		External element number for flow and quality inputs to the sewer	
INUE	C	Internal upstream element numbers	
IOLD	C	Routing solution indicator	
IOUTCT	C	Counting parameter for I/O output files	
IP		Pollutant number	
IPOL	C	Pollution control parameter	
IPRINT	C	Print control parameter	
IR	C	Element number sequencing array	
ISTMOD	C	Storage mode parameter	
ISTOUT	C	Storage outlet type parameter	
ISTTYP	C	Storage reservoir type parameter	
ITER	C	Iteration number for routing	
J		Do loop counter	
JIN	C	Input file reference numbers	

TABLE 20. (CONT'D)

Variable Name	C*	Description	Units
JJ		Do loop counter	
JN		External element numbers at which flow enters receiving water	
JOUT	C	Output file reference numbers	
JP		Number of first inlet plug in outflow	
JPLOT		Control parameter for plotting routed hydrographs and pollutographs	
JR	C	Element number sequencing array	
K		Interpolation warning flag	
KASE		Study area indicator	
KDAY		Number for the day of the week (Sunday = 1)	
KDEPTH	C	Parameter indicating form of input for D-A data	
KDT		Time-step number	
KFLAG		Interpolation warning flag	
KFULL	C	Parameter indicating surcharging	
KHOUR	C	Number for the hour of a day	hr
KJ		Do loop counter for time	
KLAND		Predominant land use within subarea	
KLASS	C	Parameter indicating form of input for Q-A data	
KMINS	C	Number for the minute of an hour	min
KNUM		Total number of subareas within a given study area in which sewage flow and quality are to be estimated	
KP		Inlet plug number	
KPRINT		Control parameter for printing sewer cross-section data	
KSTOR	C	Storage unit number	
KSTORE	C	Storage element array	
KTNUM	C	Total number of subareas	
KTSTEP	C	Total Number of time-steps	
KUNIT	C	Parameter indicating units in which water usages are tabulated	
KVAL		Shields K as criterion for deposition and resuspension	
L		Size of data array	
L		GEOM3	
LABEL	C	Flag to label last increment of flow in plug flow	
LP	C	Number of last inlet plug in outflow	
LPREV	C	LP for previous time-step	
L1		Half width of the wetted surface in the element cross-sectional area	
M	C	Current internal element number	
METHOD		Parameter indicating whether or not water usage is metered	
MLTBE		Day on which melting period begins	
MLTEN		Day on which melting period ends	
MM	C	Total number of values of AMORM and QMORM	
MMM	C	Total number of values of AMORM and QMORM	

TABLE 20. (CONT'D)

Variable Name	C	Description	Units
NSUBT		Subtotaling indicator for DMP output	
N	C	Current time-step number	
NAME	C	Name given to each user-supplied sewer cross-section	
NAREA1		Dummy variables used to calculate length of melting in INFIL	
NCNTRL		Control parameter for type of I/O interfacing mechanism	
ND		Do loop counter for converting unit	
NDD		Monthly degree/day values	degree-day
NDDAY		Subscript variable	
NDT	C	Total number of time-steps	
NDUM1		Total number of time-steps in runoff	
NDUM2		Size of time-step in RUNOFF, read off input file	sec
NDXDAY		Assigned daily degree/day values	degree-day
NDYUD		Day on which infiltration estimate is desired	
NE	C	Total number of sewer elements	
NEE		NE + 1	
NEP1		NE + 1	
NEWTON		Name of subroutine	
NFILTH		Control parameter for calling subroutine FILTH	
NGOTO		Element type number minus fifteen	
NIN	C	Internal element sequencing number	
NINFIL		Control parameter for calling subroutine INFIL	

Variable Name	C*	Description	Units
NINPUT		Total number of rainfall input locations to the sewer	
NITER		Maximum number of iterations to be made in flow routing	
NJ		Do loop counter for converting units	
NKLAS		NKLASS + 12	
NKLASS	C	Total number of user-supplied sewer cross-sections	
NN	C	Total number of values of DNORM	
NNEED		Dummy variable for sequencing elements	
NNN		Total number of values of DNORM	
NNPE		Total number of routed sewer hydrographs to be printed out	
NNYH		Total number of input hydrographs to be printed out	
NOE	C	External number of an element	
NORDER	C	External non-conduit element numbers at which runoff enters sewer	
NOS		Dummy variable	
NOUTS		Total number of hydrographs to the receiving water	
NPE	C	External element numbers at which routed outflow is printed	
NPF		Number of process flow	
NPOLL	C	Total number pollutants being routed	
NPOLS		NPOLL + 1	
NPRINT	C	Control parameter for printing sewer routing error messages	
NSCRAT	C	Data set reference numbers for temporary storage of data	

TABLE 20. (CONT'D)

Variable Name	C*	Description	Units
NSCRAT	C	Scratch tape number	
NSTOR	C	Total number of storage units	
NT		Element type	
NTOT		Total number of degree days above 750	degree-day
NTRIN		Data set reference numbers for I/O file	
NTROUT		Data set reference numbers for I/O file	
NTU		Element type	
NTX		Scratch file	
NTYPE	C	Element type	
NUE	C	External upstream element numbers	
NX		Day numbers used in assigning daily degree/day values	
NX1		Day numbers used in assigning daily degree/day values	
NX2		Day numbers used in assigning daily degree/day values	
NY		Assigned daily degree/day values	
NYN	C	External element number at which inflow to sewer is printed	
NY1		Assigned daily degree/day values	degree-day
NY2		Assigned daily degree/day values	degree-day
OP		The preparation of total infiltration for each conduit	
OPINF		Opportunity factor representing length of openings susceptible to infiltration for total areas	ft
OPNFIL		Opportunity factor representing susceptibility of each conduit to infiltration for individual areas	ft
OUT	C	Overflow hydrograph and pollutograph storage array	variable
OUTIN	C	Inflow hydrograph and pollutograph storage array	variable
OUT1	C	Printed outflows	cfs
OUT2	C	Printed pollutants	lb/min, MPN/min
O2DT2		Interpolated storage volume	cf
PCGG		Percent of dwelling units possessing garbage grinders within subarea KNUM	%
PCT1		Fraction of sediment on bottom of sewer with diameter greater than or equal to CRITD	
PCT2		Fraction of sediment in suspension with diameter greater than or equal to CRITD	
PER		Wetted perimeter of modified cross-section area	ft
PLUTO	C	Pollutant ordinates from surface runoff	lb/min
POP		Total population in each subarea	
POPDEN		Population density per acre	
POPULA		Total population in all areas	thousands
PP		Same as OUT2	
PRICE		Cost of last thousand gallons of water per billing period	¢/1,000 gal.
PRINT		Name of subroutine	

TABLE 20. (CONT'D)

Variable Name	C*	Description	Units
PS		Normalized flows	
PSI		Name of function	
PSI		Normalized flow, same as PS	
PSIMAX	C	Maximum Q/Q_f value	
PUMP	C	Constant pumping rate of pumps	cfs
P1	C	Conduit dimensional variable for computation purposes (FIRST)	
P2	C	Conduit dimensional variable for computation purposes (FIRST)	
P4	C	Conduit dimensional variable for computation purposes (FIRST)	
P5	C	Conduit dimensional variable for computation purposes (FIRST)	
P6	C	Conduit dimensional variable for computation purposes (FIRST)	
P7	C	Conduit dimensional variable for computation purposes (FIRST)	
Q	C	Sewer flows	cfs
QDWF	C	Sewage inflows	cfs
QFULL	C	Full flow capacity for conduits	cfs
QI	C	Sewer element inflow	cfs
QINF		Total infiltration	gpm
QINFIL	C	Groundwater infiltration inflows	cfs

Variable Name	C*	Description	Units
QINST	C	Water inflow rate to storage unit	cfs
QINSTL	C	Inflow rate previous time-step	cfs
QMAX	C	Maximum flow capacity for conduits	cfs
QNORM	C	Normalized flows	Q/Q_f
QO	C	Sewer element outflow	cfs
QOLD		Flow rate for previous time-step	cfs
QOUST	C	Outflow rate from storage unit	cfs
QOUSTL	C	Outflow rate previous time-step	cfs
QOUT		Outflow rate	cfs
QOUTO	C	Initial outflow rate	cfs
QO1	C	Undiverted flow in a flow divider or the flow going to the element number given in GEOM3	cfs
QO2	C	Diverted flow in a flow divider	cfs
QPF		Average daily process flow entering study system	cfs
QPUMP	C	Pumped outflow rate	cfs
QQ		Infiltration flow rate	cfs
QQDWF		Sum of DWF and infiltration flow	cfs
QQF		Ratio of total infiltration flow to DWF flow	
QUAL		Name of subroutine	
R	C	Same as P5, conduit dimensional variable for depth calculations	
RADH		Name of function	
RECEIV		Name of subroutine	

TABLE 20. (CONT'D)

Variable Name	C*	Description	Units
RFACT	C	Factor to calculate full-flow hydraulic radius	
RH		Computation variable associated with conduit flow area	
RHYD		Hydraulic radius	ft
RINFIL		Average infiltration due to rain water infiltrating into pipes from the ground	gpm
RNOFF	C	Flow ordinates from surface runoff	cfs
ROUGH	C	Conduit roughness (Manning's n)	
ROUTE		Name of subroutine	
RR		Radius of the element (circular pipe)	
RRMAX		Peak infiltration caused by residual melting ice	gpm
S		Wetted perimeter (RADH)	ft
S		Saturation value for DO (QUAL)	mg/L
SABPF		BOD contributed from industrial process flow	mg/L
SAQPF		Total industrial process flow originating within subarea KNUM	cfs
SASPF		SS contributed by industrial process flows	mg/L
SBOD	C	BOD in storage unit	lb
SBODC		BOD concentration in storage unit	mg/L
SCF	C	Supercritical flow indicator	
SCOL		Coliform concentration in storage unit	lb
SCOLC		Coliform concentration in storage unit	MPN/ml
SCOUR	C	Sediment removed from conduits	lb
SEWAGE		Measured average sewage flow	cfs
SINFIL		Infiltration due to melting residual ice	gpm

Variable Name	C*	Description	Units
SLOP		Name of subroutine	
SLOPE	C	Conduit invert slope	ft/ft ft/100 ft
SLUPE		Slope of line $-C_1\alpha - C_2$ on Figure 6-3	
SMMBOD		Summation of BOD in system	lb/sec/DT
SMMDWF		Summation of DWF in system	cfs
SMMQQ		Summation of infiltration flow rate in system	cfs
SMMSS		Summation of SS in system	lb/sec/DT
SMTDWF		Sum total of DWF and infiltration	cfs
SPG		Specific gravity of sediment	
SSCONC		Total and subtotal SS concentration of DWF	mg/L
SSCOUT		SS concentration in outflow	mg/L
SSIN	C	SS inflow rate	lb/DT
SSOUT	C	SS outflow rate	lb/DT
SSS	C	SS in storage unit	lb
SSSC		SS concentration in storage unit	mg/L
STOR	C	Water in storage	cf
STORF	C	Storage at end of storm	cf
STORL	C	Stored water previous time-step	cf
STORMX	C	Maximum storage during storm	cf
STORO	C	Initial storage	cf
SUMBOD		Sum of BOD from all process flow	lb/sec
SUMINF		Sum of DINFIL and RINFIL	gpm
SUMQPF		Sum of the process flows from all locations	cfs

TABLE 20. (CONT'D)

Variable Name	C*	Description	Units
SUMSS		Sum of SS from all process flow	lb/sec
SUM1		Sum for sewer flows	cfs
SUM2		Sum for concentration of pollution, SS	lb/sec
SUM3		The amount of solids held in suspension due to velocity of flow	lb/sec
SURGE1	C	Surcharged flow volume, last time-step	cf
SURGE2	C	Surcharged flow volume, this time-step	cf
SUSPP		Average daily SS of process flow	
TBODOT		Total BOD discharged from outfall	lb
TCA		Total contributing commercial area	acres
TCOLI		Total coliform in DWF per day	MPN/day
TDTR		Total contributing area except industrial and park and open space area	acres
TDWFA		Total computed residential and commercial area which contributed to DWF	acres
TERM		Term in routing equation	
THETA		The angle which is drawn from center of cross-section area to the wetted surface	radian
TIME	C	Time from start of simulation	sec
TIME2M		Time since start of inflow	min
TINA		Total contributing industrial area	acres
TITLE	C	Title associated with I/O	
TOTA		Total study area from which ABOD and ASUSO were taken	acres
TOTAL		Sum of all incoming sewer flow	cfs
TOTAL1		Sum of all pollutant flow rates from sewer element immediately upstream	lb/sec
TOTAL2		Pollutant flow rate of incoming DWF	variable
TOTAL3		Pollutant flow rate of incoming runoff	lb/sec
TOTAL4		Pollutant flow rate of all flow and scouring effect	lb/sec
TOTBOD		Total of BOD	lb/day
TOTPOP		Total population	
TOTSS		Total SS	lb/day
TPOA		Total park and open space area	acres
TRAA		Total contributing average income below $15,000 but above $7,000 residential area	acres
TRANS		Name of subroutine	
TRGGA		Total area from TRHA, TRAA, TRLA that contributes additional waste from garbage grinders	acres
TRHA		Total contributing high income above $15,000 residential area	acres
TRLA		Total contributing low income below $7,000 residential area	acres
TSSOUT		Total SS discharged from outfall	lb
TSTCST		Name of subroutine	
TSTORG		Name of subroutine	
TSTRDT		Name of subroutine	
TZERO		Time storm started	sec
ULEN		Average distance between joints in study area sewers	ft
ULIMIT		Upper limit of bed load of solids	lb

TABLE 20. (CONT'D)

Variable Name	C*	Description	Units
VALUE		Market value of average dwelling unit within subarea KNUM	$1000's
VEL		Name of a function	
VOLIN	C	Water inflow per time-step	cf
VOLOUT	C	Water outflow per time-step	cf
VOL1		Previous volume of wastewater within each element	cf
VOL2		Current volume of wastewater within each element	cf
WATER		Winter water use for KNUM (units of KNUM)	variable
WD		Weight on spatial derivative in routing flows	
WDWF	C	Sewage pollutant concentrations	lb/sec
WTDWFA		Weight strength of DWF contributing area (not including industrial and park and open area)	acres
WDWF1		Daily adjusted sewage BOD concentration	lb/sec
WDWF2		Daily adjusted sewage SS concentration	lb/sec
WDWF3		Daily adjusted sewage coliform concentration	MPN/sec
WEIGHT		Weir height	ft
WEIRL		Weir length	ft
WELL1	C	Wet well volume for lift stations	cf
WELL2	C	Wet well volume for lift stations	cf
WSLOPE		Slope of water surface	ft/ft
WT		Weight on time derivative in routing flows	
X		Data array member	
XE		Input to interpolation routine	
XINCOM		Income of average family living	$1000's
XL		Width of rectangular pipe	ft
XMLTBE		Floating point number MLTBE	
XMLTEN		Floating point number MLTEN	
XNDYUD		Floating point number NDYUD	
XXARG		Dummy variable used to calculate SINFIL	
Y		Data array member	
YE		Output value from interpolation routine	
YES	C	Supercritical flow indicator, flow is supercritical	

TABLE 21. TRANSPORT SAMPLE INPUT DATA
(Corresponds to Output in Tables 22 to 33)

```
   TRANSPORT
(1)      0      0
(11)BANNATYNE SEWER DISTRICT
(12)  130     80     41      5      5      1             3
(13)        300.                                 8.
(14)     0      0      1      1             1
(15)     1  102  139  141
         2  103
         3  104
         4  105
         5  106  908
         6  107
         7  108  813
         8  109
         9  110
        10  111  510
        11  112
        12  113  809
        13  114
        14  115  906
        15  116
        16  117  814
        17  118  905
        18  119
        19  120  802
        20  121
        21  122
        22
        23
        24  123
        25
        26  125
        27  124  126
        28  127
        29  128                20       60.        3.       75.       10.       4.5                 129.
        30  129  530
        31  130
        32  131
        33
        34  133
        35  134
        36  135  132
        37  136
        38  137
        39  138
       101
        40  801  540
       201
       202  803
       203  804
       204  805
       205  806
(15)301
```

TABLE 21. (CONT'D)

```
(15)302 807
   303 808
   401
   402 810 513
   403 811
   404 812
   501
   502 901
   503 902 904
   504
   505 903
   601
   701
   702 907
   510
   530
   540
   513
    41 140          20      5.5     1.59      10.      10.       3.          141.
(15) 42 142
   102   2           1   1220.0      5.0     0.04
   103   3           1    100.0      5.0     2.27
   104   4           1    200.0      5.0     0.10
   105   5           1    420.0      5.0     0.01
   106   6           1    320.0      5.0     0.05
   107   7           1    220.0      5.0     0.11
   108   8           1    320.0      4.5     0.04
   109   9           1    270.0      4.5     0.07
   110  10           1    530.0      4.5     0.08
   111  11           2    260.0   5.3333     0.02          3.8333
   112  12           2    270.0      4.0     0.12          5.1667
   113  13           2    340.0      5.0     0.04          3.3333
   114  14           2    340.0      5.0     0.16          3.3333
   115  15           2    340.0      5.0     0.10          3.3333
   116  16           2    610.0      5.0     0.02          3.3333
   117  17           1     90.       4.0     0.11
   118  18           1    300.       4.0     0.17
   119  19           1    820.       4.0     0.23
   120  20           1    840.       2.5     0.19
   121  21           1    400.       2.5     0.12
   122  22           1    400.       2.0     0.29
   123  23           1    230.       2.0     0.27
   124  24           1    100.       2.0     0.64
   125  25           1    160.       2.0     0.17
   126  26           2    100.    1.667      0.60          2.5000
   127  27           2    250.       2.0     0.20             3.0
   128  28           1    330.       4.5     0.15
   129  29           1    240.       3.5     0.16
   130  30           1    330.       3.5     0.20
   131  31           1    330.       3.5     0.32
   132  32           1    200.    3.6667     0.69
   133  33           1    290.       3.0     0.54
   134  34           1    300.       3.5     0.49
   135  35           1     50.       3.5     1.48
   136  36           1     60.    3.6667     0.58
   137  37           1    600.    3.6667     0.40
   138  38           1    740.    3.6667     0.41
   139  39           1    240.    4.4167     0.48
   801 101           1    280.       2.0     0.24
(15)802  40           1    340.       2.0     0.22
```

TABLE 21. (CONT'D)

```
(15) 803 201              2     300.     1.75     0.24          2.3333
     804 202              1     750.      2.0     0.21
     805 203              1     950.      2.0     0.16
     806 204              1     290.      2.0     0.43
     814 205              2      70.     5.00     1.29          3.3333
     807 301              1      80.      2.0     1.08
     808 302              1     550.      2.0     0.48
     809 303              1     360.      2.0     0.58
     810 401              1     610.      2.0     0.30
     811 402              1     340.      2.5     0.16
     812 403              1     840.      2.5     0.23
     813 404              1      85.      2.5     1.33
     901 501              1     670.      2.0     0.22
     902 502              1    1000.      2.0     0.24
     903 504              1     340.      2.0     0.27
     904 505              1     320.      2.0     0.26
     905 503              1     400.      3.0     0.47
     906 601              1     400.      2.0     0.52
     907 701              1     320.      2.0     0.35
     908 702              1      70.      2.0     4.67
     140  29              1    1030.      3.0     0.20
     141  41              1    5509       4.5     0.20
(15) 142  41              1     570.      3.0     0.29
(27)   1
(29)  22   19   10    6    1
(30)  22   19   10    6    1
(34)     .908     1.018     1.042     1.018     1.032     1.012      .970
(35)     .929     1.128      .964     1.030      .953     1.089      .907
(36)     .739     1.042     1.063     1.044     1.053     1.054     1.005
(37)     .600      .450      .450      .450      .450      .575      .600       .9
         .875     1.950     1.950     1.500     1.900     1.300     1.400     1.400
(37)    1.500     1.500     1.100      .800      .800      .700      .700      .650
(38)    1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
        1.0       1.0       1.0       1.0        .0       1.0       1.0       1.0
(38)    1.0       1.0       1.0       1.0        .0       1.0       1.0       1.0
(39)    1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
        1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
(39)    1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
(40)    1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
        1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
(40)    1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0
(41)  41    1    1    1    4   40109.5 103.    12.560
(42)      5.6      391.      558.     11.E09
(43)  542.2        0   268.        0   190.   352.2     54.        0
(44)   8      0.22      400.      275.
(45)  1  1320          0.005 9.23  5.4  10.  3.0 16.0 10.0    0   0   0  6.0 1
      2 28320          0.01016.34  5.4  10.  3.0 16.0 10.0    0   0   0  6.0 1
      3 30320          0.005 8.77  5.4  10.  3.0 16.0 10.0    0   0   0  6.0 1
      4 38320          0.01117.12  5.4  10.  3.0 16.0 10.0    0   0   0  6.0 1
      5 34320          0.00914.55  5.4  10.  3.0 16.0 10.0    0   0   0  6.0 1
      6 33320          0.01015.73  5.4  10.  3.0 16.0 10.0    0   0   0  6.0 1
      7  4320          0.03314.13 19.7  10.  3.0 12.5 10.0    0   0   0  5.6 1
      8 30320          0.04017.42 19.7  10.  3.0 12.5 10.0    0   0   0  5.6 1
      9 23320          0.06813.1  42.7  10.  3.0 16.0 10.0    0   0   0  5.4 1
     10 25320          0.01218.96  5.4  10.  3.0 16.0 10.0    0   0   0  6.0 1
     11402320          0.032 6.14 42.7  10.  3.0 16.0 10.0    0   0   0  5.4 1
     12401320          0.09217.70 42.7  10.  3.0 16.0 10.0    0   0   0  5.4 1
     13402320          0.10119.42 42.7  10.  3.0 16.0 10.0    0   0   0  5.4 1
     14403320          0.036 6.90 42.7  10.  3.0 16.0 10.0    0   0   0  5.4 1
(45) 15  6320          0.014 6.20 19.7  10.  3.0 12.5 10.0    0   0   0  5.6 1
```

TABLE 21. (CONT'D)

```
(45)16  8320    0.02410.00 19.7  10.  3.0 12.5 10.0  .22400.0275.0  5.6 1
   17 10320     0.05422.48 19.7  10.  3.0 12.5 10.0    0     0     0  5.6 1
   18301120     0.04011.10 30.0  10.  3.0 14.0 10.0    0     0     0  6.0 1
   19303120     0.08523.22 30.0  10.  3.0 14.0 10.0    0     0     0  6.0 1
   20 15120     0.036 9.89 30.0  10.  3.0 14.0 10.0    0     0     0  6.0 1
   21204120     0.06220.33 25.3  10.  3.0 15.0 10.0    0     0     0  7.9 1
   22203120     0.06721.33 25.9  10.  3.0 12.0 10.0    0     0     0  7.3 1
   23202120     0.07323.15 25.9  10.  3.0 12.0 10.0    0     0     0  7.3 1
   24201120     0.026 8.47 25.9  10.  3.0 12.0 10.0    0     0     0  7.3 1
   25101120     0.015 5.14 25.3  10.  3.0 15.0 10.0    0     0     0  7.9 1
   26 40120     0.016 5.41 25.3  10.  3.0 15.0 10.0    0     0     0  7.9 1
   27 19120     0.022 7.30 25.3  10.  3.0 15.0 10.0    0     0     0  7.9 1
   28 20120     0.05116.62 25.3  10.  3.0 15.0 10.0    0     0     0  7.9 1
   29 22120     0.04414.41 25.3  10.  3.0 15.0 10.0    0     0     0  7.9 1
   30501120     0.03310.76 25.3  10.  3.0 15.0 10.0    0     0     0  7.9 1
   31502120     0.019 6.31 25.3  10.  3.0 15.0 10.0    0     0     0  7.9 1
   32503120     0.03210.40 25.3  10.  3.0 15.0 10.0    0     0     0  7.9 1
   33505120     0.03812.60 25.3  10.  3.0 15.0 10.0    0     0     0  7.9 1
   34504120     0.03812.60 25.3  10.  3.0 15.0 10.0    0     0     0  7.9 1
   35601120     0.05815.90 30.0  10.  3.0 14.0 10.0    0     0     0  6.0 1
   36 13120     0.05717.51 30.0  10.  3.0 14.0 10.0    0     0     0  6.0 1
   37 10120     0.02811.90 19.7  10.  3.0 12.5 10.0    0     0     0  5.6 1
   38  9120     0.02611.15 19.7  10.  3.0 12.5 10.0    0     0     0  5.6 1
   39702320     0.016 7.13 19.7  10.  3.0 12.5 10.0    0     0     0  5.6 1
   40701320     0.03814.92 19.7  10.  3.0 12.5 10.0    0     0     0  5.6 1
(45)41 41320    0.01218.96  5.4  10.  3.0 16.0 10.0    0     0     0  6.0 1
```

TABLE 22. SEQUENCE NUMBERING FOR BANNATYNE DISTRICT

* * * * * ELEMENT LINKAGES AND COMPUTATION SEQUENCE * * * * *

ELEMENT NO. ZERO IS GIVEN INTERNAL NO. = NO. ELEMENTS + 1 = 131

EXTERNAL ELEMENT NUMBER	INTERNAL ELEMENT NUMBER	TYPE	DESCRIPTION	UPSTREAM ELEMENTS (EXTERNAL NOS.) 1	2	3
1	1	16	MANHOLE	102	139	141
2	2	16	MANHOLE	103	0	0
3	3	16	MANHOLE	104	0	0
4	4	16	MANHOLE	105	0	0
5	5	16	MANHOLE	106	908	0
6	6	16	MANHOLE	107	0	0
7	7	16	MANHOLE	108	813	0
8	8	16	MANHOLE	109	0	0
9	9	16	MANHOLE	110	0	0
10	10	16	MANHOLE	111	510	0
11	11	16	MANHOLE	112	0	0
12	12	16	MANHOLE	113	809	0
13	13	16	MANHOLE	114	0	0
14	14	16	MANHOLE	115	906	0
15	15	16	MANHOLE	116	0	0
16	16	16	MANHOLE	117	814	0
17	17	16	MANHOLE	118	905	0
18	18	16	MANHOLE	119	0	0
19	19	16	MANHOLE	120	802	0
20	20	16	MANHOLE	121	0	0
21	21	16	MANHOLE	122	0	0
22	22	16	MANHOLE	0	0	0
23	23	16	MANHOLE	0	0	0
24	24	16	MANHOLE	123	0	0
25	25	16	MANHOLE	0	0	0
26	26	16	MANHOLE	125	0	0
27	27	16	MANHOLE	124	126	0
28	28	16	MANHOLE	127	0	0
29	29	20	FLOW DIVIDER	128	0	0
30	30	16	MANHOLE	129	530	0
31	31	16	MANHOLE	130	0	0
32	32	16	MANHOLE	131	0	0
33	33	16	MANHOLE	0	0	0
34	34	16	MANHOLE	133	0	0
35	35	16	MANHOLE	134	0	0
36	36	16	MANHOLE	135	132	0
37	37	16	MANHOLE	136	0	0
38	38	16	MANHOLE	137	0	0
39	39	16	MANHOLE	138	0	0
101	40	16	MANHOLE	0	0	0
40	41	16	MANHOLE	801	540	0
201	42	16	MANHOLE	0	0	0
202	43	16	MANHOLE	803	0	0
203	44	16	MANHOLE	804	0	0
204	45	16	MANHOLE	805	0	0
205	46	16	MANHOLE	806	0	0
206	47	16	MANHOLE	0	0	0

ORDER OF COMPUTATION SEQUENCE	EXTERNAL NUMBER	INTERNAL NUMBER	INTERNAL UPSTREAM ELEMENT NUMBERS (PROCEEDING DOWNSTREAM)		
1	22	22	131	131	131
2	23	23	131	131	131
3	25	25	131	131	131
4	33	33	131	131	131
5	101	40	131	131	131
6	201	42	131	131	131
7	301	47	131	131	131
8	401	50	131	131	131
9	501	54	131	131	131
10	504	57	131	131	131
11	601	59	131	131	131
12	701	60	131	131	131
13	510	62	131	131	131
14	530	63	131	131	131
15	540	64	131	131	131
16	513	65	131	131	131
17	122	88	22	131	131
18	21	21	88	131	131
19	121	87	21	131	131
20	20	20	87	131	131
21	120	86	20	131	131
22	123	89	23	131	131
23	24	24	89	131	131
24	124	90	24	131	131
25	125	91	25	131	131
26	26	26	91	131	131
27	126	92	26	131	131
28	27	27	90	92	131
29	127	93	27	131	131
30	28	28	93	131	131
31	128	94	28	131	131
32	29	29	94	131	131
33	129	95	29	131	131
34	30	30	95	63	131
35	130	96	30	131	131
36	31	31	96	131	131
37	131	97	31	131	131
38	32	32	97	131	131
39	132	98	32	131	131
40	133	99	33	131	131
41	34	34	99	131	131
42	134	100	34	131	131
43	35	35	100	131	131
44	135	101	35	131	131
45	36	36	101	98	131
46	136	102	36	131	131
47	37	37	102	131	131

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TABLE 22. (CONT'D)

302	48	16	MANHOLE	807	0	0	48	137	103	37	131	131
303	49	16	MANHOLE	808	0	0	49	38	38	103	131	131
401	50	16	MANHOLE	0	0	0	50	138	104	38	131	131
402	51	16	MANHOLE	810	513	0	51	39	39	104	131	131
403	52	16	MANHOLE	811	0	0	52	139	105	39	131	131
404	53	16	MANHOLE	812	0	0	53	801	106	40	131	131
501	54	16	MANHOLE	0	0	0	54	40	41	106	64	131
502	55	16	MANHOLE	901	0	0	55	802	107	41	131	131
503	56	16	MANHOLE	902	904	0	56	19	19	86	107	131
504	57	16	MANHOLE	0	0	0	57	119	85	19	131	131
505	58	16	MANHOLE	903	0	0	58	18	18	85	131	131
601	59	16	MANHOLE	0	0	0	59	118	84	18	131	131
701	60	16	MANHOLE	0	0	0	60	803	108	42	131	131
702	61	16	MANHOLE	907	0	0	61	202	43	108	131	131
510	62	16	MANHOLE	0	0	0	62	804	109	43	131	131
530	63	16	MANHOLE	0	0	0	63	203	44	109	131	131
540	64	16	MANHOLE	0	0	0	64	805	110	44	131	131
513	65	16	MANHOLE	0	0	0	65	204	45	110	131	131
41	66	20	FLOW DIVIDER	140	0	0	66	806	111	45	131	131
42	67	16	MANHOLE	142	0	0	67	205	46	111	131	131
102	68	1	CIRCULAR	2	0	0	68	814	112	46	131	131
103	69	1	CIRCULAR	3	0	0	69	807	113	87	131	131
104	70	1	CIRCULAR	4	0	0	70	302	48	113	131	131
105	71	1	CIRCULAR	5	0	0	71	808	114	48	131	131
106	72	1	CIRCULAR	6	0	0	72	303	49	114	131	131
107	73	1	CIRCULAR	7	0	0	73	809	115	49	131	131
108	74	1	CIRCULAR	8	0	0	74	810	116	50	131	131
109	75	1	CIRCULAR	9	0	0	75	402	51	116	65	131
110	76	1	CIRCULAR	10	0	0	76	811	117	51	131	131
111	77	2	RECTANGULAR	11	0	0	77	403	52	117	131	131
112	78	2	RECTANGULAR	12	0	0	78	812	118	52	131	131
113	79	2	RECTANGULAR	13	0	0	79	404	53	118	131	131
114	80	2	RECTANGULAR	14	0	0	80	813	119	53	131	131
115	81	2	RECTANGULAR	15	0	0	81	901	120	54	131	131
116	82	2	RECTANGULAR	16	0	0	82	502	55	120	131	131
117	83	1	CIRCULAR	17	0	0	83	902	121	55	131	131
118	84	1	CIRCULAR	18	0	0	84	903	122	57	131	131
119	85	1	CIRCULAR	19	0	0	85	505	58	122	131	131
120	86	1	CIRCULAR	20	0	0	86	904	123	58	131	131
121	87	1	CIRCULAR	21	0	0	87	503	56	121	123	131
122	88	1	CIRCULAR	22	0	0	88	905	124	56	131	131
123	89	1	CIRCULAR	23	0	0	89	17	17	84	124	131
124	90	1	CIRCULAR	24	0	0	90	117	83	17	131	131
125	91	1	CIRCULAR	25	0	0	91	16	16	83	112	131
126	92	2	RECTANGULAR	26	0	0	92	116	82	16	131	131
127	93	2	RECTANGULAR	27	0	0	93	15	15	82	131	131
128	94	1	CIRCULAR	28	0	0	94	115	81	15	131	131
129	95	1	CIRCULAR	29	0	0	95	906	125	59	131	131
130	96	1	CIRCULAR	30	0	0	96	14	14	81	125	131
131	97	1	CIRCULAR	31	0	0	97	114	80	14	131	131
132	98	1	CIRCULAR	32	0	0	98	13	13	80	131	131
133	99	1	CIRCULAR	33	0	0	99	113	79	13	131	131
134	100	1	CIRCULAR	34	0	0	100	12	12	79	115	131
135	101	1	CIRCULAR	35	0	0	101	112	78	12	131	131
136	102	1	CIRCULAR	36	0	0	102	11	11	78	131	131
137	103	1	CIRCULAR	37	0	0	103	111	77	11	131	131
138	104	1	CIRCULAR	38	0	0	104	10	10	77	62	131
139	105	1	CIRCULAR	39	0	0	105	110	76	10	131	131
801	106	1	CIRCULAR	101	0	0	106	9	9	76	131	131
802	107	1	CIRCULAR	40	0	0	107	109	75	9	131	131
803	108	2	RECTANGULAR	201	0	0	108	8	8	75	131	131

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TABLE 22. (CONT'D)

804	109	1	CIRCULAR	202	0	0	109	108	74	8	131	131
805	110	1	CIRCULAR	203	0	0	110	7	7	74	119	131
806	111	1	CIRCULAR	204	0	0	111	107	73	7	131	131
814	112	2	RECTANGULAR	205	0	0	112	6	6	73	131	131
807	113	1	CIRCULAR	301	0	0	113	106	72	6	131	131
808	114	1	CIRCULAR	302	0	0	114	907	126	60	131	131
809	115	1	CIRCULAR	303	0	0	115	702	61	126	131	131
810	116	1	CIRCULAR	401	0	0	116	908	127	61	131	131
811	117	1	CIRCULAR	402	0	0	117	5	5	72	127	131
812	118	1	CIRCULAR	403	0	0	118	105	71	5	131	131
813	119	1	CIRCULAR	404	0	0	119	4	4	71	131	131
901	120	1	CIRCULAR	501	0	0	120	104	70	4	131	131
902	121	1	CIRCULAR	502	0	0	121	3	3	70	131	131
903	122	1	CIRCULAR	504	0	0	122	103	69	3	131	131
904	123	1	CIRCULAR	505	0	0	123	2	2	69	131	131
905	124	1	CIRCULAR	503	0	0	124	102	68	2	131	131
906	125	1	CIRCULAR	601	0	0	125	140	128	29	131	131
907	126	1	CIRCULAR	701	0	0	126	41	66	128	131	131
908	127	1	CIRCULAR	702	0	0	127	141	129	66	131	131
140	128	1	CIRCULAR	29	0	0	128	1	1	68	105	129
141	129	1	CIRCULAR	41	0	0	129	142	130	66	131	131
142	130	1	CIRCULAR	41	0	0	130	42	67	130	131	131

TABLE 23. ELEMENT DATA FOR BANNATYNE DISTRICT

*** HYDRAULIC DESIGN ROUTINE IS USED ***

NUMBER OF ELEMENTS = 130
NUMBER OF TIME INT = 80
TIME INTERVAL = 300.0 SECONDS

* * * * * ELEMENT PARAMETERS * * * * *

EXT. ELE. NUM.	TYPE	DESCRIPTION	SLOPE (FT/FT)	DISTANCE (FT)	MANNING ROUGHNESS	GEOM1 (FT)	GEOM2 (FT)	GEOM3 (FT)	NUMBER OF BARRELS	AFULL (SQ.FT)	QFULL (CFS)	QMAX (CFS)	SUPER-CRITICAL FLOW WHEN LESS THAN 95% FULL?
1	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
2	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
3	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
4	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
5	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
6	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
7	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
8	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
9	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
10	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
11	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
12	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
13	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
14	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
15	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
16	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
17	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
18	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
19	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
20	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
21	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
22	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
23	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
24	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
25	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
26	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
27	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
28	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
29	20	FLOW DIVIDER	75.0000	60.0	10.0000	3.0	4.5	129.0	1.0	0.0	0.0	0.0	
30	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
31	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
32	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
33	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
34	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
35	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
36	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
37	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
38	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
39	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
101	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
40	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
201	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
202	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
203	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	

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TABLE 23. (CONT'D)

204	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
205	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
301	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
302	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
303	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
401	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
402	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
403	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
404	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
501	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
502	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
503	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
504	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
505	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
601	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
701	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
702	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
510	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
530	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
540	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
513	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
41	20	FLOW DIVIDER	10.0000	5.5	10.0000	1.6	3.0	141.0	1.0	0.0	0.0	0.0	
42	16	MANHOLE	0.1000	0.0	0.0130	0.0	0.0	0.0	1.0	0.0	0.0	0.0	
102	1	CIRCULAR	0.0004	1220.0	0.0130	5.0	0.0	0.0	1.0	19.635	52.229	56.407	NO
103	1	CIRCULAR	0.0227	100.0	0.0130	5.0	0.0	0.0	1.0	19.635	393.452	424.928	YES
104	1	CIRCULAR	0.0010	200.0	0.0130	5.0	0.0	0.0	1.0	19.635	82.581	89.187	NO
105	1	CIRCULAR	0.0001	420.0	0.0130	5.0	0.0	0.0	1.0	19.635	26.114	28.203	NO
106	1	CIRCULAR	0.0005	320.0	0.0130	5.0	0.0	0.0	1.0	19.635	58.393	63.065	NO
107	1	CIRCULAR	0.0011	220.0	0.0130	5.0	0.0	0.0	1.0	19.635	86.612	93.540	NO
108	1	CIRCULAR	0.0004	320.0	0.0130	4.5	0.0	0.0	1.0	15.904	39.436	42.591	NO
109	1	CIRCULAR	0.0007	270.0	0.0130	4.5	0.0	0.0	1.0	15.904	52.168	56.342	NO
110	1	CIRCULAR	0.0008	530.0	0.0130	4.5	0.0	0.0	1.0	15.904	55.770	60.232	NO
111	2	RECTANGULAR	0.0002	260.0	0.0130	5.3	3.8	0.0	1.0	20.404	35.635	40.198	NO
112	2	RECTANGULAR	0.0012	270.0	0.0130	4.0	5.2	0.0	1.0	20.667	88.878	106.839	NO
113	2	RECTANGULAR	0.0004	340.0	0.0130	5.0	3.3	0.0	1.0	16.666	38.205	42.782	NO
114	2	RECTANGULAR	0.0016	340.0	0.0130	5.0	3.3	0.0	1.0	16.666	76.409	85.564	NO
115	2	RECTANGULAR	0.0010	340.0	0.0130	5.0	3.3	0.0	1.0	16.666	60.407	67.645	NO
116	2	RECTANGULAR	0.0002	610.0	0.0130	5.0	3.3	0.0	1.0	16.666	27.015	30.252	NO
117	1	CIRCULAR	0.0011	90.0	0.0130	4.0	0.0	0.0	1.0	12.566	47.769	51.591	NO
118	1	CIRCULAR	0.0017	300.0	0.0130	4.0	0.0	0.0	1.0	12.566	59.385	64.136	NO
119	1	CIRCULAR	0.0023	820.0	0.0130	4.0	0.0	0.0	1.0	12.566	69.074	74.600	NO
120	1	CIRCULAR	0.0019	800.0	0.0130	2.5	0.0	0.0	1.0	4.909	17.927	19.361	NO
121	1	CIRCULAR	0.0012	400.0	0.0130	2.5	0.0	0.0	1.0	4.909	14.247	15.387	NO
122	1	CIRCULAR	0.0029	400.0	0.0130	2.0	0.0	0.0	1.0	3.142	12.215	13.193	NO
123	1	CIRCULAR	0.0027	230.0	0.0130	2.0	0.0	0.0	1.0	3.142	11.787	12.730	NO
124	1	CIRCULAR	0.0064	100.0	0.0130	2.0	0.0	0.0	1.0	3.142	18.147	19.598	NO
125	1	CIRCULAR	0.0017	160.0	0.0130	2.0	0.0	0.0	1.0	3.142	9.353	10.101	NO
126	2	RECTANGULAR	0.0060	100.0	0.0130	1.7	2.5	0.0	1.0	4.167	23.310	28.429	NO
127	2	RECTANGULAR	0.0020	250.0	0.0130	2.0	3.0	0.0	1.0	6.000	21.878	26.683	NO
128	1	CIRCULAR	0.0015	330.0	0.0130	4.5	0.0	0.0	1.0	15.904	76.367	82.476	NO
129	1	CIRCULAR	0.0016	240.0	0.0130	3.5	0.0	0.0	1.0	9.621	40.352	43.580	NO
130	1	CIRCULAR	0.0020	330.0	0.0130	3.5	0.0	0.0	1.0	9.621	45.115	48.724	NO
131	1	CIRCULAR	0.0032	330.0	0.0130	3.5	0.0	0.0	1.0	9.621	57.067	61.632	NO
132	1	CIRCULAR	0.0069	200.0	0.0130	3.7	0.0	0.0	1.0	10.559	94.868	102.457	NO
133	1	CIRCULAR	0.0054	290.0	0.0130	3.0	0.0	0.0	1.0	7.069	49.105	53.077	NO
134	1	CIRCULAR	0.0049	300.0	0.0130	3.5	0.0	0.0	1.0	9.621	70.616	76.266	NO
135	1	CIRCULAR	0.0148	50.0	0.0130	3.5	0.0	0.0	1.0	9.621	122.726	132.545	NO
136	1	CIRCULAR	0.0058	60.0	0.0130	3.7	0.0	0.0	1.0	10.559	86.978	93.936	NO
137	1	CIRCULAR	0.0040	600.0	0.0130	3.7	0.0	0.0	1.0	10.559	72.231	78.009	NO
138	1	CIRCULAR	0.0047	740.0	0.0130	3.7	0.0	0.0	1.0	10.559	73.128	78.979	NO
139	1	CIRCULAR	0.0048	240.0	0.0130	4.4	0.0	0.0	1.0	15.321	129.969	140.367	NO

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TABLE 23. (CONT'D)

B01	1	CIRCULAR	0.0024	280.0	0.0130	2.0	0.0	0.0	1.0	3.142	11.112	12.001	NO
B02	1	CIRCULAR	0.0022	340.0	0.0130	2.0	0.0	0.0	1.0	3.142	10.639	11.491	NO
B03	2	RECTANGULAR	0.0024	300.0	0.0130	1.8	2.3	0.0	1.0	4.083	14.443	17.390	NO
B04	1	CIRCULAR	0.0021	750.0	0.0130	2.0	0.0	0.0	1.0	3.142	10.395	11.226	NO
B05	1	CIRCULAR	0.0016	950.0	0.0130	2.0	0.0	0.0	1.0	3.142	9.073	9.799	NO
B06	1	CIRCULAR	0.0043	290.0	0.0130	2.0	0.0	0.0	1.0	3.142	14.874	16.064	NO
B14	2	RECTANGULAR	0.0129	70.0	0.0130	5.0	3.3	0.0	1.0	16.666	216.960	242.956	NO
B07	1	CIRCULAR	0.0108	80.0	0.0130	2.0	0.0	0.0	1.0	3.142	23.573	25.459	NO
B08	1	CIRCULAR	0.0048	550.0	0.0130	2.0	0.0	0.0	1.0	3.142	15.715	16.973	NO
B09	1	CIRCULAR	0.0058	360.0	0.0130	2.0	0.0	0.0	1.0	3.142	17.275	18.657	NO
B10	1	CIRCULAR	0.0030	610.0	0.0130	2.0	0.0	0.0	1.0	3.142	12.424	13.418	NO
B11	1	CIRCULAR	0.0016	340.0	0.0130	2.5	0.0	0.0	1.0	4.909	16.451	17.767	NO
B12	1	CIRCULAR	0.0023	840.0	0.0130	2.5	0.0	0.0	1.0	4.909	19.724	21.302	NO
B13	1	CIRCULAR	0.0133	85.0	0.0130	2.5	0.0	0.0	1.0	4.909	47.431	51.225	NO
901	1	CIRCULAR	0.0022	670.0	0.0130	2.0	0.0	0.0	1.0	3.142	10.639	11.491	NO
902	1	CIRCULAR	0.0024	1000.0	0.0130	2.0	0.0	0.0	1.0	3.142	11.112	12.001	NO
903	1	CIRCULAR	0.0027	340.0	0.0130	2.0	0.0	0.0	1.0	3.142	11.787	12.730	NO
904	1	CIRCULAR	0.0026	320.0	0.0130	2.0	0.0	0.0	1.0	3.142	11.566	12.492	NO
905	1	CIRCULAR	0.0047	400.0	0.0130	3.0	0.0	0.0	1.0	7.069	45.849	49.517	NO
906	1	CIRCULAR	0.0052	400.0	0.0130	2.0	0.0	0.0	1.0	3.142	16.357	17.666	NO
907	1	CIRCULAR	0.0035	320.0	0.0130	2.0	0.0	0.0	1.0	3.142	13.420	14.493	NO
908	1	CIRCULAR	0.0467	70.0	0.0130	2.0	0.0	0.0	1.0	3.142	49.019	52.940	YES
140	1	CIRCULAR	0.0020	1030.0	0.0130	3.0	0.0	0.0	1.0	7.069	29.909	32.301	NO
141	1	CIRCULAR	0.0020	5.5	0.0130	4.5	0.0	0.0	1.0	15.904	88.181	95.235	NO
142	1	CIRCULAR	0.0020	570.0	0.0130	3.0	0.0	0.0	1.0	7.069	29.909	32.301	NO

EPSILON = 0.000100 NO. OF ITERATIONS IN ROUTING ROUTINE = 4

HYDROGRAPHS AND POLLUTOGRAPHS PROVIDED TO SUBSEQUENT PROGRAMS FOR THE FOLLOWING ELEMENTS:

1

TABLE 24. QUANTITY AND QUALITY OF DWF FOR EACH SUBAREA PARTIAL LISTING

A1BOD = 1457.98 LBS/DAY/CFS
A1SS = 2125.86 LBS/DAY/CFS
A1COLI = 1.20E 14 MPN/DAY PER CAPITA
ADWF = 5.60 CFS

KNUM	INPUT	DWF CFS	+ INFIL CFS	= QDDWF CFS	KLAND	DWBOD LBS/MIN	DWSS LBS/MIN	TOTPOP PERSONS	BODCONC MG/L	SSCONC MG/L	COLIFORMS MPN/100ML
1	1	0.005	0.0	0.005	3	0.00	0.01				
	SUBTOTALS										
		0.00	0.0	0.00		0.02 LBS	0.03 LBS	50.	243.	355.	4.89E 10
2	28	0.010	0.0	0.010	3	0.01	0.01				
	SUBTOTALS										
		0.01	0.0	0.01		0.07 LBS	0.10 LBS	138.	243.	355.	4.51E 10
3	30	0.005	0.0	0.005	3	0.00	0.01				
	SUBTOTALS										
		0.02	0.0	0.02		0.09 LBS	0.13 LBS	185.	243.	355.	4.55E 10
4	38	0.011	0.0	0.011	3	0.01	0.01				
	SUBTOTALS										
		0.03	0.0	0.03		0.17 LBS	0.25 LBS	278.	243.	355.	4.40E 10
5	34	0.009	0.0	0.009	3	0.01	0.01				
	SUBTOTALS										
		0.04	0.0	0.04		0.18 LBS	0.27 LBS	356.	243.	355.	4.37E 10
6	33	0.010	0.0	0.010	3	0.01	0.01				
	SUBTOTALS										
		0.05	0.0	0.05		0.23 LBS	0.33 LBS	441.	243.	355.	4.33E 10
7	4	0.033	0.0	0.033	3	0.03	0.04				
	SUBTOTALS										
		0.08	0.0	0.08		0.38 LBS	0.55 LBS	720.	243.	355.	4.25E 10

COMPARISON OF MEASURED AND CALCULATED TOTAL SEWAGE FLOW: ADWF = 5.60 CFS SMTDWF = 1.49 CFS
CORRECTION FACTOR (CF2) OF 3.76 APPLIED TO THE DWF (QUANTITY AND QUALITY) AT EACH INLET

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TABLE 25. ASSUMED DAILY AND HOURLY VARIATION IN SEWAGE FLOW

DAILY AND HOURLY CORRECTION FACTORS
FOR SEWAGE DATA

DAY	DVDWF	DVBOD	DVSS	DVCOLI
1	0.908	0.929	0.739	
2	1.018	1.128	1.042	
3	1.042	0.964	1.063	
4	1.018	1.030	1.044	
5	1.032	0.953	1.053	
6	1.012	1.089	1.054	
7	0.970	0.907	1.005	
HOUR				
1	0.600	1.000	1.000	1.000
2	0.450	1.000	1.000	1.000
3	0.450	1.000	1.000	1.000
4	0.450	1.000	1.000	1.000
5	0.450	1.000	1.000	1.000
6	0.575	1.000	1.000	1.000
7	0.600	1.000	1.000	1.000
8	0.900	1.000	1.000	1.000
9	0.875	1.000	1.000	1.000
10	1.950	1.000	1.000	1.000
11	1.950	1.000	1.000	1.000
12	1.500	1.000	1.000	1.000
13	1.400	1.000	1.000	1.000
14	1.300	1.000	1.000	1.000
15	1.400	1.000	1.000	1.000
16	1.400	1.000	1.000	1.000
17	1.500	1.000	1.000	1.000
18	1.500	1.000	1.000	1.000
19	1.100	1.000	1.000	1.000
20	0.800	1.000	1.000	1.000
21	0.800	1.000	1.000	1.000
22	0.700	1.000	1.000	1.000
23	0.700	1.000	1.000	1.000
24	0.650	1.000	1.000	1.000

TABLE 26. INITIAL SOLIDS LOAD PRIOR TO STORM

INITIAL BED OF SOLIDS (LBS) IN SEWER DUE TO
8.0 DAYS OF DRY WEATHER PRIOR TO STORM

ELEMENT NUMBER	SOLIDS IN BOTTOM (LBS)
122	5.64753
121	44.00568
120	12.34108
123	6.21521
124	0.83233
125	21.19177
126	12.09743
127	39.24684
128	19.52774
129	12.52185
130	12.97454
131	6.46395
132	0.56338
133	2.20997
134	2.54834
135	0.50974
136	0.66885
137	3.42577
138	2.89857
139	1.98454
801	11.56138
802	7.90552
119	13.56308
118	19.02502
803	43.72255
804	10.72179
805	17.53096
806	1.10211
814	0.91026
807	0.16256
808	2.37862
809	0.49558
810	5.74380
811	17.99324
812	9.10995
813	0.35515
901	7.28804
902	7.15515
903	5.58098
904	7.74704
905	1.38111
117	39.64977
116	1618.27417
115	71.64992
906	1.90263
114	40.36253
113	390.26489
112	81.22876
[illegible]	1609.09229
110	77.51508

TABLE 27. FLOWS AND CONCENTRATIONS INITIALIZED TO DRY WEATHER FLOW

ELEMENT FLOWS, AREAS, AND CONCENTRATIONS ARE INITIALIZED TO DRY WEATHER FLOW AND INFILTRATION VALUES.

ELE. NO.	TYPE	FLOW (CFS)	AREA (SQ. FT.)	INIT. VEL. (FPS)	BOD (LBS/CF)	S.S. (LBS/CF)	FCOLI. (MPN/ML)	CPOLL NO.A
122	1	0.068	0.065	1.0441	0.0161	0.0187	1.15E 13	
121	1	0.068	0.089	0.7633	0.0161	0.0187	1.15E 13	
120	1	0.146	0.130	1.1228	0.0161	0.0187	1.15E 13	
123	1	0.105	0.088	1.1831	0.0141	0.0164	1.14E 13	
124	1	0.105	0.066	1.5751	0.0141	0.0164	1.14E 13	
125	1	0.018	0.024	0.7830	0.0141	0.0164	1.19E 13	
126	2	0.018	0.036	0.5172	0.0141	0.0164	1.19E 13	
127	2	0.123	0.168	0.7320	0.0141	0.0164	1.15E 13	
128	1	0.138	0.110	1.2628	0.0141	0.0164	1.16E 13	
129	1	0.138	0.125	1.1031	0.0141	0.0164	1.16E 13	
130	1	0.208	0.168	1.2333	0.0141	0.0164	1.17E 13	
131	1	0.208	0.133	1.5600	0.0141	0.0164	1.17E 13	
132	1	0.208	0.088	2.3628	0.0141	0.0164	1.17E 13	
133	1	0.015	0.008	1.8285	0.0141	0.0164	1.18E 13	
134	1	0.029	0.015	1.9303	0.0141	0.0164	1.20E 13	
135	1	0.029	0.009	3.3548	0.0141	0.0164	1.20E 13	
136	1	0.237	0.109	2.1663	0.0141	0.0164	1.18E 13	
137	1	0.237	0.132	1.7990	0.0141	0.0164	1.18E 13	
138	1	0.254	0.139	1.8214	0.0141	0.0164	1.18E 13	
139	1	0.254	0.114	2.2311	0.0141	0.0164	1.18E 13	
801	1	0.023	0.025	0.9303	0.0161	0.0187	1.20E 13	
802	1	0.048	0.054	0.8907	0.0161	0.0187	1.20E 13	
119	1	0.228	0.157	1.4456	0.0161	0.0187	1.16E 13	
118	1	0.228	0.183	1.2429	0.0161	0.0187	1.16E 13	
803	2	0.040	0.073	0.5459	0.0161	0.0187	1.17E 13	
804	1	0.152	0.128	1.1852	0.0161	0.0187	1.15E 13	
805	1	0.255	0.201	1.2700	0.0161	0.0187	1.15E 13	
806	1	0.351	0.178	1.9731	0.0161	0.0187	1.15E 13	
814	2	0.351	0.188	1.8695	0.0161	0.0187	1.15E 13	
807	1	0.062	0.031	1.9734	0.0129	0.0150	1.16E 13	
808	1	0.062	0.047	1.3156	0.0129	0.0150	1.16E 13	
809	1	0.192	0.104	1.8422	0.0129	0.0150	1.14E 13	
810	1	0.141	0.106	1.3323	0.0141	0.0164	1.14E 13	
811	1	0.346	0.256	1.3528	0.0141	0.0164	1.14E 13	
812	1	0.401	0.250	1.6063	0.0141	0.0164	1.14E 13	
813	1	0.401	0.134	3.0047	0.0141	0.0164	1.14E 13	
901	1	0.051	0.057	0.8907	0.0161	0.0187	1.15E 13	
902	1	0.080	0.077	1.0449	0.0161	0.0187	1.15E 13	
903	1	0.058	0.059	0.9867	0.0161	0.0187	1.17E 13	
904	1	0.117	0.097	1.2035	0.0161	0.0187	1.17E 13	
905	1	0.246	0.143	1.7198	0.0161	0.0187	1.16E 13	
117	1	0.474	0.383	1.2364	0.0161	0.0187	1.16E 13	
116	2	0.824	1.164	0.7080	0.0161	0.0187	1.15E 13	
115	2	0.880	0.728	1.2082	0.0159	0.0185	1.15E 13	
906	1	0.089	0.064	1.3894	0.0129	0.0150	1.14E 13	
114	2	0.969	0.668	1.4503	0.0157	0.0182	1.15E 13	
113	2	1.056	1.093	0.9668	0.0154	0.0179	1.16E 13	
112	2	1.249	0.994	1.2567	0.0150	0.0175	1.16E 13	
111	2	1.249	1.582	0.7891	0.0150	0.0175	1.16E 13	
110	1	1.375	0.930	1.4787	0.0149	0.0173	1.16E 13	
109	1	1.415	0.993	1.4249	0.0149	0.0172	1.16E 13	
108	1	1.452	1.228	1.1818	0.0148	0.0172	1.16E 13	
107	1	1.893	1.036	1.7895	0.0147	0.0170	1.15E 13	
106	1	1.893	1.036	1.6830	0.0147	0.0170	1.16E 13	
907	1	0.058	0.052	1.1234	0.0141	0.0164	1.07E 13	

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TABLE 28. SELECTED INLET HYDROGRAPHS FROM RUNOFF BLOCK

BANNATYNE SEWER DISTRICT

TOTAL SIMULATION TIME = 24000.0 SECONDS. TIME STEP = 300.0 SECONDS.

INFLOW POLLUTOGRAPHS AND HYDROGRAPHS AT THE FOLLOWING EXTERNAL ELEMENT NUMBERS:

1	28	530	38	34	33	4	30	23	26	402	401	513	403	6	8	10	301	303	15
540	203	202	201	101	40	19	20	22	501	502	503	505	504	601	13	510	9	702	701
41																			

SELECTED INLET HYDROGRAPHS - CFS

EXTERNAL ELEMENT NUMBER	TIME STEP 1	2	3	4	5	6	7	8	9	10
22	0.000	0.005	0.082	1.059	3.085	4.180	3.595	2.498	1.726	1.441
	1.372	1.225	0.889	0.578	0.523	0.761	0.995	0.972	0.803	0.594
	0.434	0.338	0.243	0.165	0.119	0.092	0.075	0.063	0.056	0.051
	0.047	0.044	0.042	0.040	0.039	0.038	0.037	0.037	0.036	0.036
	0.035	0.035	0.035	0.035	0.034	0.034	0.034	0.034	0.034	0.034
	0.034	0.034	0.034	0.034	0.034	0.034	0.033	0.033	0.033	0.033
	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033
	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033
19	0.000	0.003	0.047	0.609	1.710	2.188	1.779	1.198	0.825	0.708
	0.687	0.609	0.428	0.270	0.256	0.397	0.519	0.492	0.396	0.286
	0.206	0.161	0.114	0.076	0.058	0.045	0.034	0.029	0.026	0.024
	0.022	0.021	0.020	0.019	0.019	0.019	0.018	0.018	0.018	0.018
	0.018	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
10	0.001	0.009	0.136	1.769	4.962	6.490	5.536	3.900	2.715	2.274
	2.155	1.907	1.364	0.878	0.815	1.218	1.572	1.507	1.237	0.908
	0.659	0.513	0.364	0.243	0.173	0.132	0.107	0.091	0.080	0.073
	0.067	0.064	0.061	0.059	0.057	0.056	0.055	0.055	0.054	0.054
	0.053	0.053	0.053	0.053	0.052	0.052	0.052	0.052	0.052	0.052
	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	0.052	0.052	0.052	0.052	0.051	0.051	0.051	0.051	0.051	0.051
	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
6	0.000	0.003	0.048	0.598	1.612	1.918	1.439	0.937	0.651	0.584
	0.579	0.507	0.342	0.210	0.212	0.351	0.455	0.415	0.325	0.230
	0.165	0.130	0.091	0.059	0.043	0.033	0.027	0.023	0.021	0.019
	0.018	0.017	0.017	0.016	0.016	0.016	0.015	0.015	0.015	0.015
	0.015	0.015	0.015	0.015	0.015	0.014	0.014	0.014	0.014	0.014
	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
1	0.002	0.014	0.131	1.319	2.468	1.998	1.307	0.827	0.592	0.658
	0.641	0.499	0.240	0.138	0.277	0.549	0.559	0.395	0.296	0.175
	0.128	0.113	0.057	0.027	0.021	0.019	0.018	0.017	0.017	0.016
	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016
	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016

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TABLE 29. SELECTED INLET POLLUTOGRAPHS FROM RUNOFF BLOCK

SELECTED INLET POLLUTOGRAPHS

EXTERNAL ELEMENT NUMBER	TIME STEP 1	2	3	4	5	6	7	8	9	10
				*** BOD IN LBS/MIN ***						
22	0.0	0.0	0.016	0.323	0.748	0.697	0.378	0.169	0.077	0.046
	0.036	0.027	0.016	0.008	0.006	0.010	0.014	0.013	0.009	0.006
	0.003	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
				** SUSPENDED SOLIDS IN LBS/MIN **						
22	0.0	0.0	0.050	4.239	11.740	12.296	6.935	3.096	1.376	0.803
	0.604	0.442	0.248	0.114	0.079	0.137	0.205	0.190	0.132	0.077
	0.042	0.024	0.014	0.007	0.004	0.002	0.002	0.001	0.001	0.001
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
				*** COLIFORM IN MPN/MIN ***						
22	0.0	0.0	4.92E 07	7.30E 08	2.04E 09	2.57E 09	2.03E 09	1.31E 09	8.54E 08	6.79E 08
	6.21E 08	5.36E 08	3.79E 08	2.42E 08	2.15E 08	3.05E 08	3.90E 08	3.72E 08	3.02E 08	2.19E 08
	1.58E 08	1.22E 08	8.69E 07	5.89E 07	4.23E 07	3.25E 07	2.63E 07	2.23E 07	1.96E 07	1.77E 07
	1.63E 07	1.53E 07	1.46E 07	1.40E 07	1.36E 07	1.32E 07	1.29E 07	1.27E 07	1.25E 07	1.24E 07
	1.22E 07	1.21E 07	1.20E 07	1.19E 07	1.19E 07	1.18E 07	1.17E 07	1.17E 07	1.16E 07	1.16E 07
	1.15E 07	1.15E 07	1.14E 07	1.14E 07	1.14E 07	1.14E 07	1.13E 07	1.13E 07	1.13E 07	1.13E 07
	1.13E 07	1.12E 07	1.12E 07	1.12E 07	1.12E 07	1.12E 07	1.12E 07	1.12E 07	1.11E 07	1.11E 07
	1.11E 07	1.11E 07	1.11E 07	1.11E 07	1.11E 07	1.11E 07	1.10E 07	1.10E 07	1.10E 07	1.10E 07
				*** BOD IN LBS/MIN ***						
19	0.0	0.0	0.009	0.185	0.409	0.367	0.197	0.089	0.042	0.027
	0.022	0.017	0.009	0.005	0.004	0.006	0.009	0.008	0.006	0.003
	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
				** SUSPENDED SOLIDS IN LBS/MIN **						
19	0.0	0.0	0.032	2.514	6.552	6.541	3.625	1.636	0.749	0.471
	0.377	0.281	0.153	0.068	0.051	0.099	0.146	0.130	0.087	0.049
	0.026	0.015	0.008	0.004	0.003	0.002	0.001	0.001	0.001	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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TABLE 30. SOLIDS LOAD AT END OF STORM

BED OF SOLIDS IN SEWER AT END OF STORM

ELEMENT NUMBER	SOLIDS IN BOTTOM (LBS)
122	0.04675
121	0.14682
120	0.10854
123	0.03988
124	0.00498
125	0.12614
126	0.02586
127	0.16116
128	0.16068
129	0.13356
130	0.07150
131	0.01212
132	0.00712
133	0.01112
134	0.01348
135	0.00126
136	0.00871
137	0.01169
138	0.01190
139	0.01101
A01	0.04593
A02	0.05295
119	0.05244
118	0.14055
A03	0.09549
A04	0.07410
A05	0.12633
A06	0.01534
A14	0.00765
A07	0.00230
A08	0.00729
A09	0.00695
A10	0.01801
A11	0.09875
A12	0.02299
A13	0.00038
901	0.07084
902	0.06670
903	0.05486
904	0.04711
905	0.01248
117	0.31539
116	9.75153
115	0.46397
906	0.00463
114	0.06433
113	1.81140
112	0.38108
111	10.62959
110	0.04660
109	0.66148

TABLE 31. OUTFLOWS FOR SELECTED MANHOLES

SELECTED OUTFLOW HYDROGRAPHS - CFS

EXTERNAL ELEMENT NUMBER	TIME STEP 1	2	3	4	5	6	7	8	9	10
22	0.068	0.072	0.150	1.126	3.153	4.247	3.663	2.566	1.794	1.508
	1.440	1.292	0.956	0.646	0.591	0.829	1.081	1.058	0.890	0.681
	0.520	0.424	0.329	0.253	0.206	0.178	0.161	0.150	0.146	0.141
	0.137	0.134	0.132	0.131	0.129	0.128	0.128	0.127	0.126	0.126
	0.171	0.170	0.170	0.170	0.170	0.170	0.169	0.169	0.169	0.169
	0.169	0.169	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165
	0.165	0.165	0.165	0.165	0.326	0.326	0.326	0.326	0.326	0.326
	0.326	0.326	0.326	0.326	0.326	0.326	0.326	0.326	0.326	0.326
19	0.228	0.231	0.357	3.176	13.667	24.053	25.543	21.134	15.092	11.721
	10.320	9.465	7.805	5.686	4.384	4.749	6.265	6.892	6.402	5.293
	4.119	3.240	2.575	1.959	1.503	1.209	1.014	0.884	0.797	0.742
	0.698	0.667	0.642	0.623	0.609	0.597	0.588	0.580	0.574	0.569
	0.591	0.649	0.672	0.693	0.700	0.701	0.700	0.699	0.698	0.696
	0.695	0.698	0.691	0.686	0.683	0.680	0.678	0.678	0.677	0.677
	0.676	0.676	0.676	0.675	0.780	1.016	1.127	1.200	1.212	1.217
	1.218	1.218	1.218	1.217	1.217	1.217	1.217	1.217	1.217	1.217
10	1.376	1.402	1.725	5.747	19.481	40.836	59.833	59.604	57.962	49.580
	43.783	38.617	34.597	29.235	25.042	22.858	21.657	19.999	19.736	20.206
	18.781	16.946	15.190	13.017	10.256	8.554	7.125	6.015	5.128	4.456
	3.988	3.649	3.403	3.225	3.092	2.990	2.911	2.849	2.802	2.766
	2.835	2.968	3.073	3.151	3.238	3.298	3.360	3.396	3.454	3.468
	3.502	3.515	3.507	3.489	3.484	3.484	3.486	3.479	3.464	3.457
	3.449	3.452	3.449	3.449	3.944	4.436	4.890	5.321	5.671	5.990
	6.152	6.408	6.563	6.590	6.640	6.668	6.691	6.702	6.715	6.719
6	1.875	1.883	1.980	4.128	16.132	42.709	67.418	76.547	66.261	65.618
	58.258	49.968	46.048	39.427	33.691	29.166	27.896	27.692	26.401	24.778
	23.899	22.246	19.746	17.432	15.095	12.455	10.212	8.673	7.541	6.513
	5.775	5.212	4.773	4.480	4.249	4.083	3.986	3.850	3.771	3.712
	3.695	3.818	4.021	4.186	4.285	4.368	4.445	4.501	4.557	4.598
	4.640	4.668	4.688	4.684	4.662	4.656	4.646	4.648	4.647	4.641
	4.630	4.619	4.617	4.615	4.777	5.521	6.413	7.036	7.455	7.835
	8.174	8.403	8.651	8.790	8.918	8.949	8.981	9.040	9.045	9.067
1	2.289	2.310	2.550	6.096	23.282	60.077	96.253	114.545	85.775	77.410
	99.042	80.362	68.401	63.765	56.043	50.981	46.103	45.541	43.696	41.789
	37.604	33.813	30.614	27.776	24.504	21.365	18.555	15.983	13.402	11.502
	10.072	8.962	7.977	7.232	6.643	6.182	5.822	5.557	5.343	5.193
	5.081	5.006	4.951	5.178	5.302	5.497	5.656	5.757	5.825	5.897
	5.960	6.022	6.038	6.064	6.074	6.075	6.066	6.049	6.038	6.029
	6.022	6.015	6.005	5.994	6.030	6.343	6.746	7.326	7.961	8.571
	8.951	9.559	10.178	10.865	10.785	11.028	11.286	11.243	11.383	11.356

TABLE 32. OUTFLOW POLLUTOGRAPHS FOR SELECTED MANHOLES

SELECTED OUTFLOW POLLUTOGRAPHS

EXTERNAL ELEMENT NUMBER	TIME STEP 1	2	3	4	5	6	7	8	9	10
				*** BOD IN LBS/MIN ***						
22	0.066	0.066	0.082	0.389	0.810	0.762	0.440	0.235	0.143	0.112
	0.101	0.092	0.081	0.073	0.071	0.075	0.097	0.096	0.093	0.090
	0.087	0.086	0.085	0.085	0.084	0.084	0.084	0.084	0.088	0.088
	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088
	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131
	0.131	0.131	0.128	0.128	0.128	0.128	0.128	0.128	0.128	0.128
	0.128	0.128	0.128	0.128	0.284	0.284	0.284	0.284	0.284	0.284
	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284
				** SUSPENDED SOLIDS IN LBS/MIN **						
22	0.076	0.076	0.126	0.315	11.816	12.372	7.011	3.172	1.452	0.879
	0.680	0.518	0.324	0.190	0.155	0.213	0.302	0.287	0.229	0.174
	0.139	0.122	0.111	0.104	0.101	0.100	0.099	0.098	0.102	0.102
	0.102	0.102	0.102	0.102	0.102	0.102	0.102	0.102	0.102	0.101
	0.152	0.152	0.152	0.152	0.152	0.152	0.152	0.152	0.152	0.152
	0.152	0.152	0.148	0.148	0.148	0.148	0.148	0.148	0.148	0.148
	0.148	0.148	0.148	0.148	0.330	0.330	0.330	0.330	0.330	0.330
	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330
				*** COLIFORM IN MPN/MIN ***						
22	4.67E 13	4.67E 13	4.67E 13	4.67E 13	4.67E 13	4.67E 13	4.67E 13	4.67E 13	4.67E 13	4.67E 13
	4.67E 13	4.67E 13	4.67E 13	4.67E 13	4.67E 13	4.67E 13	5.97E 13	5.97E 13	5.97E 13	5.97E 13
	5.97E 13	5.97E 13	5.97E 13	5.97E 13	5.97E 13	5.97E 13	5.97E 13	5.97E 13	6.23E 13	6.23E 13
	6.23E 13	6.23E 13	6.23E 13	6.23E 13	6.23E 13	6.23E 13	6.23E 13	6.23E 13	6.23E 13	6.23E 13
	9.34E 13	9.34E 13	9.34E 13	9.34E 13	9.34E 13	9.34E 13	9.34E 13	9.34E 13	9.34E 13	9.34E 13
	9.34E 13	9.34E 13	9.09E 13	9.09E 13	9.09E 13	9.09E 13	9.09E 13	9.09E 13	9.09E 13	9.09E 13
	9.09E 13	9.09E 13	9.09E 13	9.09E 13	2.02E 14	2.02E 14	2.02E 14	2.02E 14	2.02E 14	2.02E 14
	2.02E 14	2.02E 14	2.02E 14	2.02E 14	2.02E 14	2.02E 14	2.02E 14	2.02E 14	2.02E 14	2.02E 14
				*** BOD IN LBS/MIN ***						
19	0.220	0.214	0.218	1.053	3.316	3.984	2.862	1.711	0.935	0.582
	0.449	0.390	0.335	0.279	0.238	0.236	0.301	0.340	0.337	0.318
	0.294	0.277	0.273	0.266	0.258	0.255	0.254	0.255	0.261	0.268
	0.273	0.278	0.282	0.284	0.286	0.288	0.289	0.290	0.291	0.292
	0.320	0.371	0.397	0.422	0.432	0.436	0.438	0.439	0.440	0.440
	0.440	0.440	0.438	0.434	0.432	0.430	0.429	0.429	0.429	0.429
	0.429	0.428	0.429	0.428	0.530	0.739	0.851	0.930	0.945	0.951
	0.953	0.954	0.954	0.955	0.955	0.955	0.955	0.955	0.955	0.955
				** SUSPENDED SOLIDS IN LBS/MIN **						
19	0.993	1.951	2.176	13.873	49.361	63.488	46.210	26.598	13.138	6.905
	4.418	3.211	2.174	1.307	0.827	0.817	1.142	1.264	1.094	0.846
	0.658	0.498	0.426	0.373	0.337	0.317	0.305	0.301	0.308	0.310
	0.315	0.320	0.324	0.327	0.330	0.332	0.334	0.335	0.337	0.337
	0.370	0.428	0.459	0.489	0.502	0.507	0.509	0.510	0.511	0.511
	0.511	0.511	0.509	0.504	0.502	0.499	0.498	0.497	0.497	0.497
	0.497	0.497	0.497	0.497	0.613	0.854	0.988	1.082	1.100	1.107
	1.108	1.108	1.109	1.108	1.109	1.108	1.109	1.108	1.109	1.108

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TABLE 32. (CONT'D)

SELECTED OUTFLOW POLLUTOGRAPHS

EXTERNAL ELEMENT NUMBER	TIME STEP 1	2	3	4	5	6	7	8	9	10
					*** BOD IN MG/L ****					
22	258.088	241.893	146.437	92.332	68.696	48.006	32.426	24.484	21.257	19.834
	18.807	19.116	22.725	30.400	32.326	24.221	24.097	24.399	27.961	35.176
	44.837	54.272	69.248	89.934	109.655	126.334	139.596	149.920	160.432	166.408
	170.984	174.512	177.255	179.409	181.117	182.483	183.587	184.487	185.229	185.843
	205.593	205.945	206.244	206.499	206.719	206.909	207.074	207.150	207.286	207.405
	207.510	207.604	206.517	206.593	206.661	206.723	206.779	206.830	206.877	206.919
	206.957	206.992	207.025	207.055	232.869	232.884	232.897	232.909	232.921	232.931
	232.941	232.951	232.959	232.967	232.975	232.982	232.989	232.995	233.001	233.006
					*** SUSPENDED SOLIDS IN MG/L ***					
22	299.350	280.565	225.331	1024.884	1002.453	779.147	512.016	330.626	216.565	155.922
	126.374	107.292	90.553	78.910	70.271	68.870	70.661	72.597	68.933	68.313
	71.292	76.723	89.965	110.840	131.620	149.558	164.018	175.349	187.096	193.722
	198.836	202.766	205.853	208.257	210.191	211.716	212.976	213.979	214.830	215.512
	238.430	238.819	239.169	239.448	239.707	239.912	240.109	240.183	240.346	240.470
	240.599	240.693	239.437	239.512	239.601	239.660	239.735	239.783	239.847	239.885
	239.940	239.970	240.019	240.042	270.046	270.058	270.078	270.087	270.106	270.113
	270.130	270.135	270.151	270.155	270.169	270.172	270.185	270.187	270.199	270.201
					***COLIFORM IN MPN/100ML ***					
22	4.04E 10	3.78E 10	1.83E 10	2.43E 09	8.70E 08	6.46E 08	7.49E 08	1.07E 09	1.53E 09	1.82E 09
	1.90E 09	2.12E 09	2.87E 09	4.25E 09	4.64E 09	3.31E 09	3.29E 09	3.31E 09	3.94E 09	5.15E 09
	6.73E 09	8.26E 09	1.06E 10	1.39E 10	1.70E 10	1.97E 10	2.17E 10	2.34E 10	2.50E 10	2.60E 10
	2.67E 10	2.72E 10	2.77E 10	2.80E 10	2.83E 10	2.85E 10	2.87E 10	2.88E 10	2.89E 10	2.90E 10
	3.21E 10	3.22E 10	3.22E 10	3.23E 10	3.23E 10	3.23E 10	3.24E 10	3.24E 10	3.24E 10	3.24E 10
	3.24E 10	3.24E 10	3.23E 10	3.23E 10	3.23E 10	3.23E 10	3.23E 10	3.23E 10	3.23E 10	3.23E 10
	3.23E 10	3.23E 10	3.23E 10	3.24E 10	3.64E 10	3.64E 10	3.64E 10	3.64E 10	3.64E 10	3.64E 10
	3.64E 10	3.64E 10	3.64E 10	3.64E 10	3.64E 10	3.64E 10	3.64E 10	3.64E 10	3.64E 10	3.64E 10
					*** BOD IN MG/L ****					
19	258.172	247.094	163.307	88.698	64.908	44.309	29.970	21.659	16.572	13.289
	11.627	11.015	11.491	13.126	14.503	13.271	12.838	13.202	14.095	16.079
	19.096	22.888	28.312	36.270	45.951	56.422	66.980	77.273	87.576	96.786
	104.711	111.592	117.259	121.940	125.817	129.001	131.639	133.813	135.621	137.138
	144.661	153.040	158.106	162.690	165.025	166.445	167.396	168.081	168.607	169.019
	169.365	169.648	169.598	169.321	169.242	169.080	169.110	169.192	169.293	169.390
	169.490	169.579	169.669	169.747	181.810	194.653	202.078	207.228	208.426	209.109
	209.399	209.565	209.659	209.723	209.770	209.804	209.834	209.858	209.881	209.900
					*** SUSPENDED SOLIDS IN MG/L ***					
19	1167.371	2257.355	1630.472	1168.302	966.148	706.072	483.946	336.658	232.867	157.589
	114.518	90.747	74.512	61.505	50.432	46.000	48.751	49.051	45.712	42.755
	41.175	41.141	44.266	50.904	59.921	70.032	80.571	91.035	101.977	111.836
	120.675	128.359	134.971	140.348	145.034	148.757	152.050	154.597	156.912	158.667
	167.213	176.561	182.810	188.493	191.659	193.386	194.601	195.274	195.917	196.262
	196.710	196.927	196.959	196.556	196.520	196.205	196.301	196.302	196.510	196.548
	196.[illegible]	196.[illegible]	196.[illegible]	196.[illegible]	210.241	220.918	230.533	241.170	242.732	243.305
	243.497	243.495	243.559	243.528	243.601	243.573	243.648	243.621	243.695	243.666

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TABLE 33. HYDRAULIC DESIGN ROUTINE RESULTS

HYDRAULIC DESIGN ROUTINE FINAL RESULTS.

FINAL CONDUIT DIMENSIONS. ASTERISK INDICATES ALTERED CONDUITS.

* * * * * ELEMENT PARAMETERS * * * * *

EXT. ELE. NUM.	TYPE	DESCRIPTION	SLOPE (FT/FT)	DISTANCE (FT)	MANNING ROUGHNESS	GEOM1 (FT)	GEOM2 (FT)	GEOM3 (FT)	NUMBER OF BARRELS	AFULL (SQ.FT)	QFULL (CFS)	QMAX (CFS)	SUPER-CRITICAL FLOW WHEN LESS THAN 95% FULL?
102	1	*CIRCULAR	0.00040	1220.00	0.0130	6.000	0.0	0.0	1.0	28.274	84.930	91.724	NO
103	1	CIRCULAR	0.02270	100.00	0.0130	5.000	0.0	0.0	1.0	19.635	393.452	424.928	YES
104	1	CIRCULAR	0.00100	200.00	0.0130	5.000	0.0	0.0	1.0	19.635	82.581	89.187	NO
105	1	*CIRCULAR	0.00010	420.00	0.0130	7.500	0.0	0.0	1.0	44.179	76.994	83.153	NO
106	1	CIRCULAR	0.00050	320.00	0.0130	5.000	0.0	0.0	1.0	19.635	58.393	63.065	NO
107	1	CIRCULAR	0.00110	220.00	0.0130	5.000	0.0	0.0	1.0	19.635	86.612	93.540	NO
108	1	*CIRCULAR	0.00040	320.00	0.0130	5.500	0.0	0.0	1.0	23.758	67.343	72.730	NO
109	1	CIRCULAR	0.00070	270.00	0.0130	4.500	0.0	0.0	1.0	15.904	52.168	56.342	NO
110	1	CIRCULAR	0.00080	530.00	0.0130	4.500	0.0	0.0	1.0	15.904	55.770	60.232	NO
111	2	RECTANGULAR	0.00020	260.00	0.0130	5.333	3.833	0.0	1.0	20.444	35.635	40.198	NO
112	2	RECTANGULAR	0.00120	270.00	0.0130	4.000	5.167	0.0	1.0	20.667	88.878	106.639	NO
113	2	RECTANGULAR	0.00040	340.00	0.0130	5.000	3.333	0.0	1.0	16.666	38.205	42.782	NO
114	2	RECTANGULAR	0.00160	340.00	0.0130	5.000	3.333	0.0	1.0	16.666	76.409	85.564	NO
115	2	RECTANGULAR	0.00100	340.00	0.0130	5.000	3.333	0.0	1.0	16.666	60.407	67.685	NO
116	2	RECTANGULAR	0.00020	610.00	0.0130	5.000	3.333	0.0	1.0	16.666	27.015	30.252	NO
117	1	CIRCULAR	0.00110	90.00	0.0130	4.000	0.0	0.0	1.0	12.566	47.769	51.591	NO
118	1	CIRCULAR	0.00170	300.00	0.0130	4.000	0.0	0.0	1.0	12.566	59.385	64.136	NO
119	1	CIRCULAR	0.00230	820.00	0.0130	4.000	0.0	0.0	1.0	12.566	69.074	74.600	NO
120	1	CIRCULAR	0.00190	840.00	0.0130	2.500	0.0	0.0	1.0	4.909	17.927	19.361	NO
121	1	CIRCULAR	0.00120	800.00	0.0130	2.500	0.0	0.0	1.0	4.909	14.247	15.387	NO
122	1	CIRCULAR	0.00290	400.00	0.0130	2.000	0.0	0.0	1.0	3.142	12.215	13.193	NO
123	1	CIRCULAR	0.00270	230.00	0.0130	2.000	0.0	0.0	1.0	3.142	11.787	12.730	NO
124	1	CIRCULAR	0.00640	100.00	0.0130	2.000	0.0	0.0	1.0	3.142	18.147	19.598	NO
125	1	CIRCULAR	0.00170	160.00	0.0130	2.000	0.0	0.0	1.0	3.142	9.353	10.101	NO
126	2	RECTANGULAR	0.00600	100.00	0.0130	1.667	2.500	0.0	1.0	4.167	23.310	28.429	NO
127	2	RECTANGULAR	0.00200	250.00	0.0130	2.000	3.000	0.0	1.0	6.000	21.878	26.683	NO
128	1	CIRCULAR	0.00150	330.00	0.0130	4.500	0.0	0.0	1.0	15.904	76.367	82.476	NO
129	1	CIRCULAR	0.00160	280.00	0.0130	3.500	0.0	0.0	1.0	9.621	40.352	43.580	NO
130	1	CIRCULAR	0.00200	330.00	0.0130	3.500	0.0	0.0	1.0	9.621	45.115	48.724	NO
131	1	CIRCULAR	0.00320	330.00	0.0130	3.500	0.0	0.0	1.0	9.621	57.067	61.632	NO
132	1	CIRCULAR	0.00690	200.00	0.0130	3.667	0.0	0.0	1.0	10.559	94.868	102.457	NO
133	1	CIRCULAR	0.00580	290.00	0.0130	3.000	0.0	0.0	1.0	7.069	49.145	53.077	NO
134	1	CIRCULAR	0.00490	300.00	0.0130	3.500	0.0	0.0	1.0	9.621	70.616	76.266	NO
135	1	CIRCULAR	0.01480	50.00	0.0130	3.500	0.0	0.0	1.0	9.621	122.726	132.545	NO
136	1	CIRCULAR	0.00580	60.00	0.0130	3.667	0.0	0.0	1.0	10.559	86.978	93.936	NO
137	1	CIRCULAR	0.00400	600.00	0.0130	3.667	0.0	0.0	1.0	10.559	72.231	78.009	NO
138	1	CIRCULAR	0.00410	740.00	0.0130	3.667	0.0	0.0	1.0	10.559	73.128	78.979	NO
139	1	CIRCULAR	0.00480	240.00	0.0130	4.417	0.0	0.0	1.0	15.321	129.969	140.367	NO
801	1	CIRCULAR	0.00240	280.00	0.0130	2.000	0.0	0.0	1.0	3.142	11.112	12.001	NO
802	1	*CIRCULAR	0.00220	340.00	0.0130	2.250	0.0	0.0	1.0	3.976	14.565	15.731	NO
803	2	RECTANGULAR	0.00240	300.00	0.0130	1.750	2.333	0.0	1.0	4.083	14.443	17.390	NO
804	1	CIRCULAR	0.00210	750.00	0.0130	2.000	0.0	0.0	1.0	3.142	10.395	11.226	NO
805	1	*CIRCULAR	0.00160	950.00	0.0130	2.250	0.0	0.0	1.0	3.976	12.421	13.415	NO
806	1	CIRCULAR	0.00430	290.00	0.0130	2.000	0.0	0.0	1.0	3.142	14.870	16.060	NO
814	2	RECTANGULAR	0.01290	70.00	0.0130	5.000	3.333	0.0	1.0	16.666	216.960	242.956	NO
807	1	CIRCULAR	0.00240	280.00	0.0130	2.000	0.0	0.0	1.0	3.142	23.573	25.459	NO
808	1	CIRCULAR	0.00480	550.00	0.0130	2.000	0.0	0.0	1.0	3.142	15.715	16.973	NO

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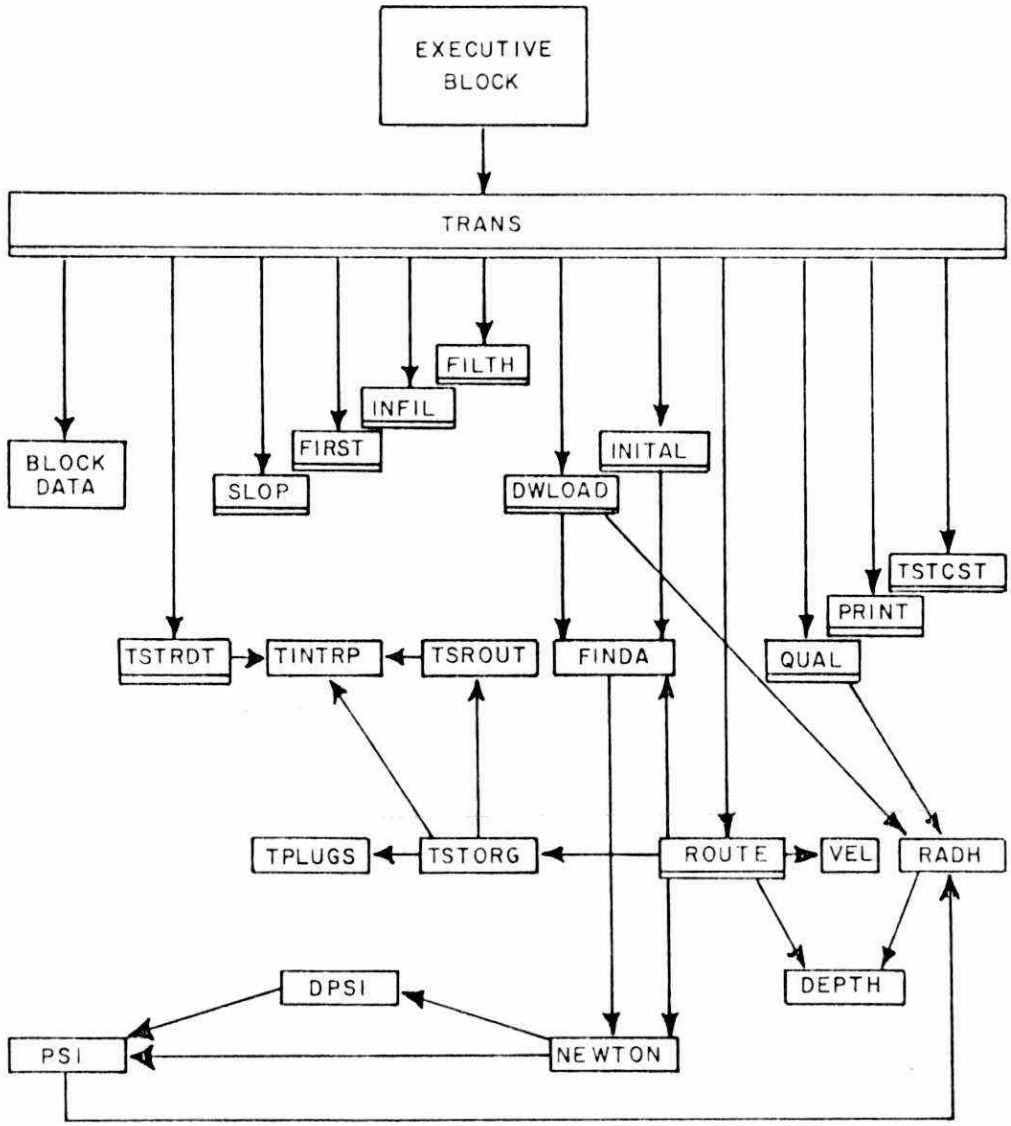
TABLE 33. (CONT'D)

809	1	CIRCULAR	0.00580	360.00	0.0130	2.000	0.0	0.0	1.0	3.142	17.275	18.657	NO
810	1	CIRCULAR	0.00300	610.00	0.0130	2.000	0.0	0.0	1.0	3.142	12.424	13.418	NO
811	1	CIRCULAR	0.00160	340.00	0.0130	2.500	0.0	0.0	1.0	4.909	16.451	17.767	NO
812	1	CIRCULAR	0.00230	840.00	0.0130	2.500	0.0	0.0	1.0	4.909	19.724	21.302	NO
813	1	CIRCULAR	0.01330	85.00	0.0130	2.500	0.0	0.0	1.0	4.909	47.431	51.225	NO
901	1	CIRCULAR	0.00220	670.00	0.0130	2.000	0.0	0.0	1.0	3.142	10.639	11.491	NO
902	1	CIRCULAR	0.00240	1000.00	0.0130	2.000	0.0	0.0	1.0	3.142	11.112	12.001	NO
903	1	CIRCULAR	0.00270	340.00	0.0130	2.000	0.0	0.0	1.0	3.142	11.787	12.730	NO
904	1	CIRCULAR	0.00260	320.00	0.0130	2.000	0.0	0.0	1.0	3.142	11.566	12.492	NO
905	1	CIRCULAR	0.00470	400.00	0.0130	3.000	0.0	0.0	1.0	7.069	45.849	49.517	NO
906	1	CIRCULAR	0.00520	400.00	0.0130	2.000	0.0	0.0	1.0	3.142	16.357	17.666	NO
907	1	CIRCULAR	0.00350	320.00	0.0130	2.000	0.0	0.0	1.0	3.142	13.420	14.493	NO
908	1	CIRCULAR	0.04670	70.00	0.0130	2.000	0.0	0.0	1.0	3.142	49.019	52.940	YES
140	1	CIRCULAR	0.00200	1030.00	0.0130	3.000	0.0	0.0	1.0	7.069	29.909	32.301	NO
141	1	CIRCULAR	0.00200	5.51	0.0130	4.500	0.0	0.0	1.0	15.904	88.181	95.235	NO
142	1	CIRCULAR	0.00200	570.00	0.0130	3.000	0.0	0.0	1.0	7.069	29.909	32.301	NO



Note: Arrows point from the calling program to the called program. Boxes with double underline represent major subroutines.

FIGURE 12. TRANSPORT BLOCK

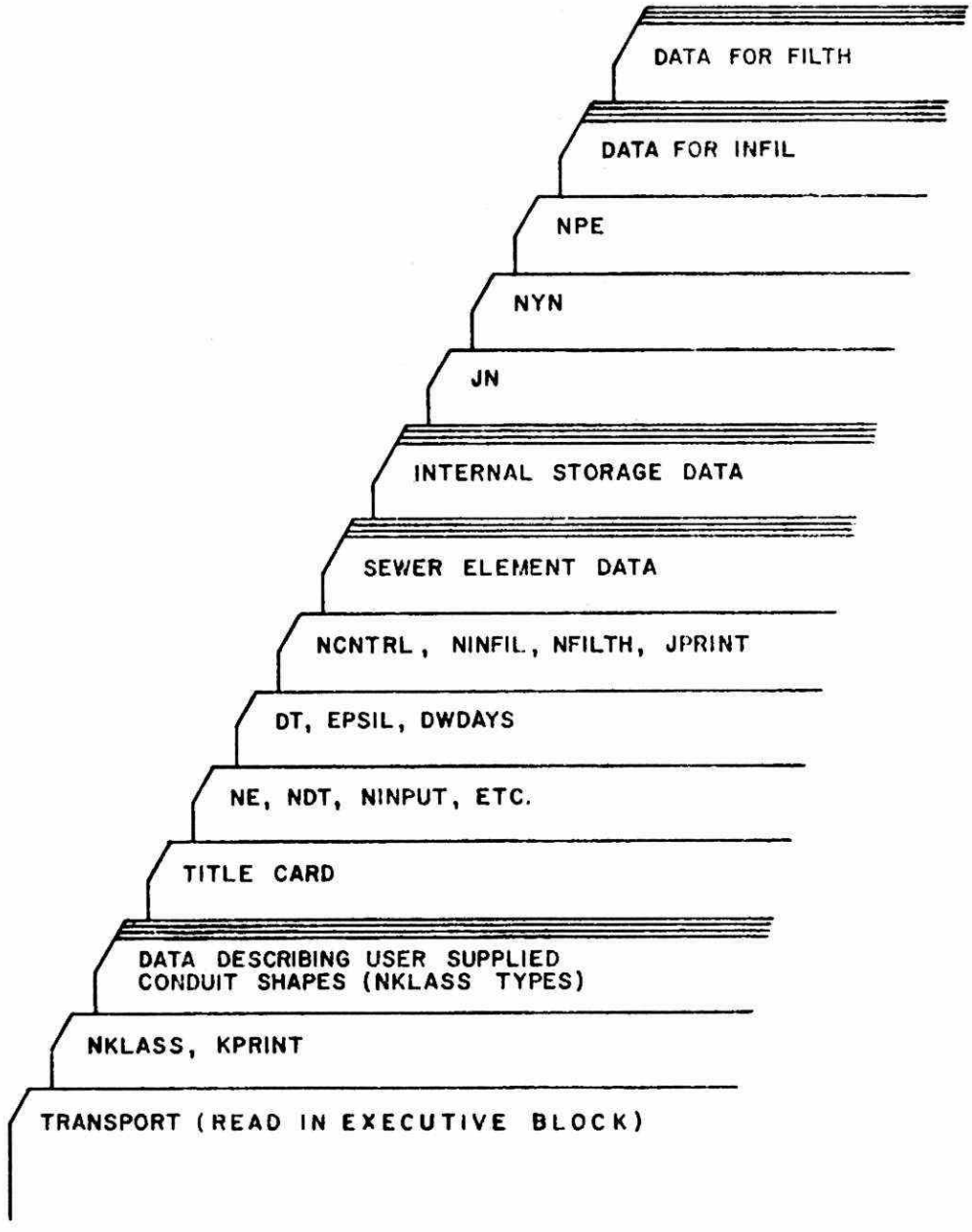
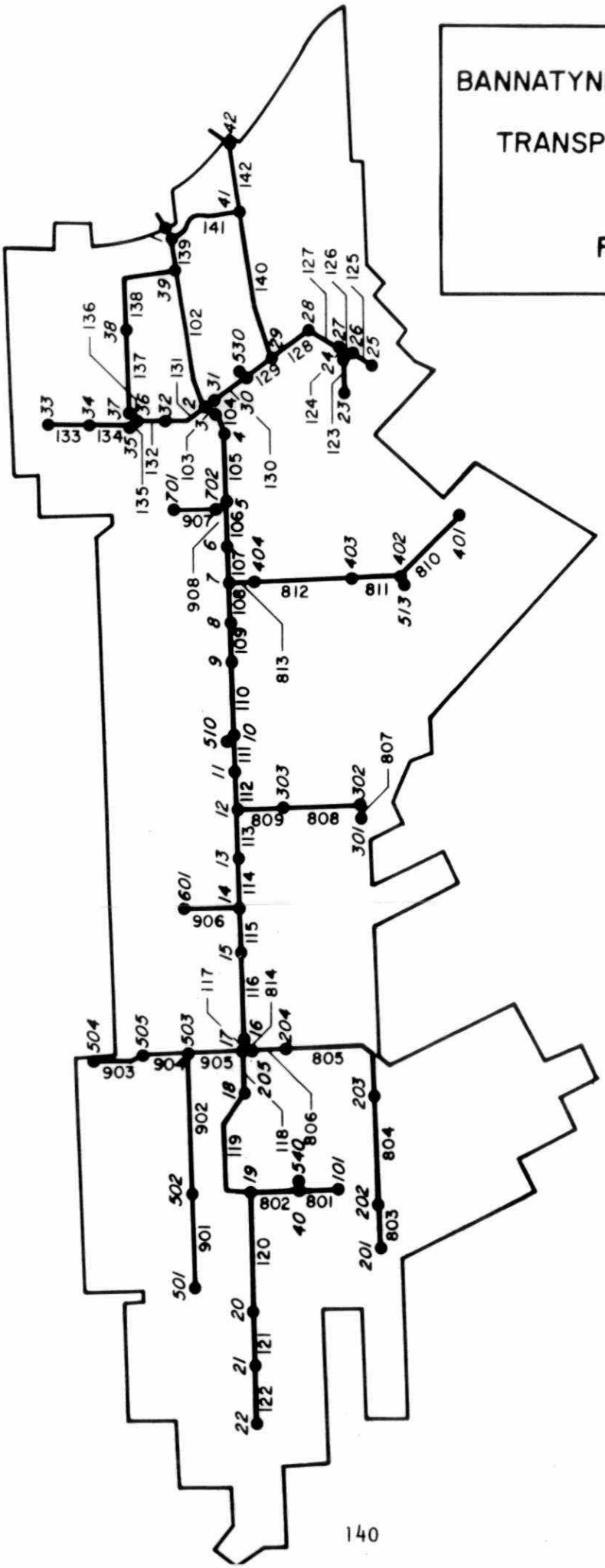


FIGURE 13. DATA DECK FOR THE TRANSPORT BLOCK

BANNATYNE SEWER DISTRICT

TRANSPORT NETWORK

FIG. 14



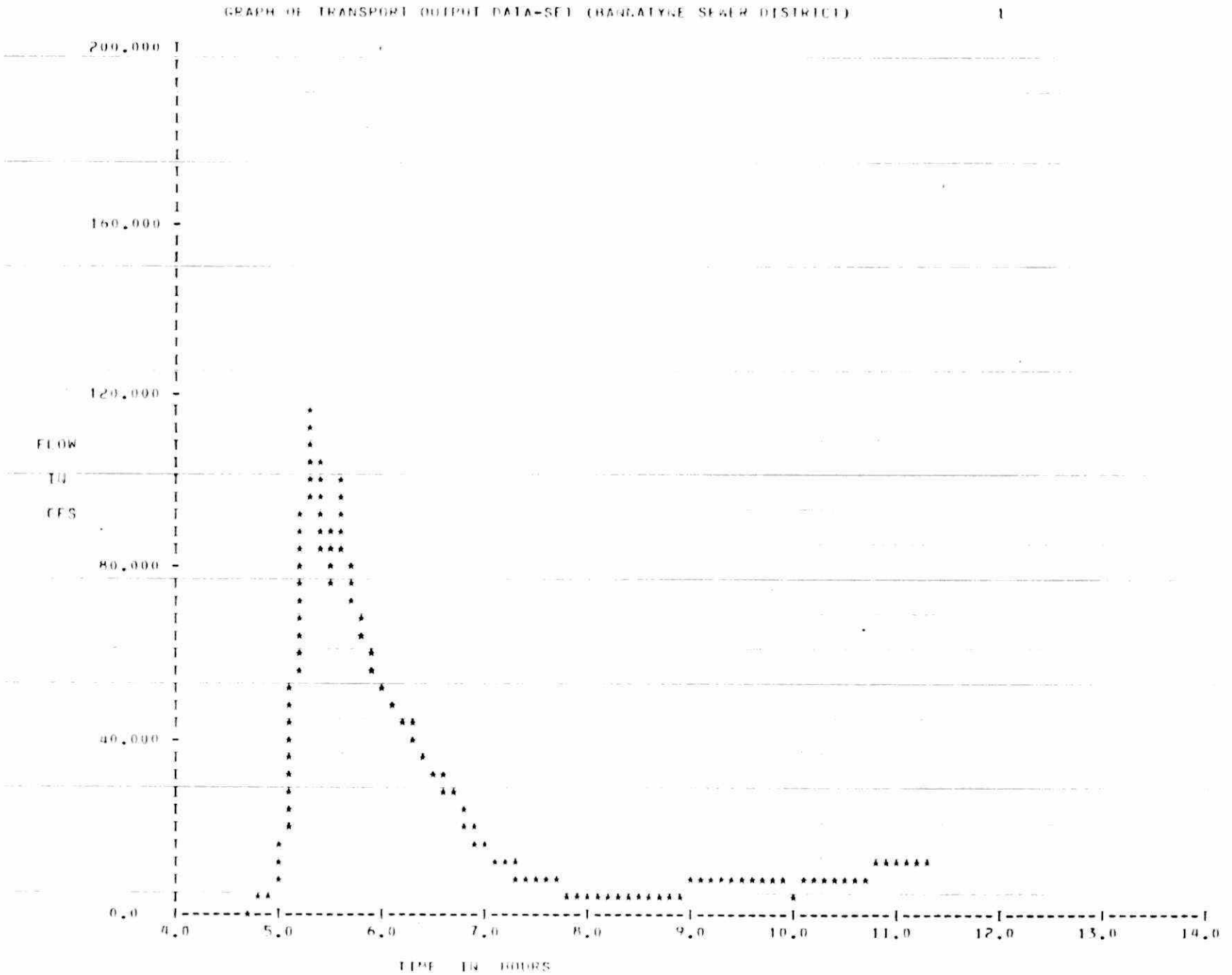


FIGURE 15. HYDROGRAPH AT OUTFALL

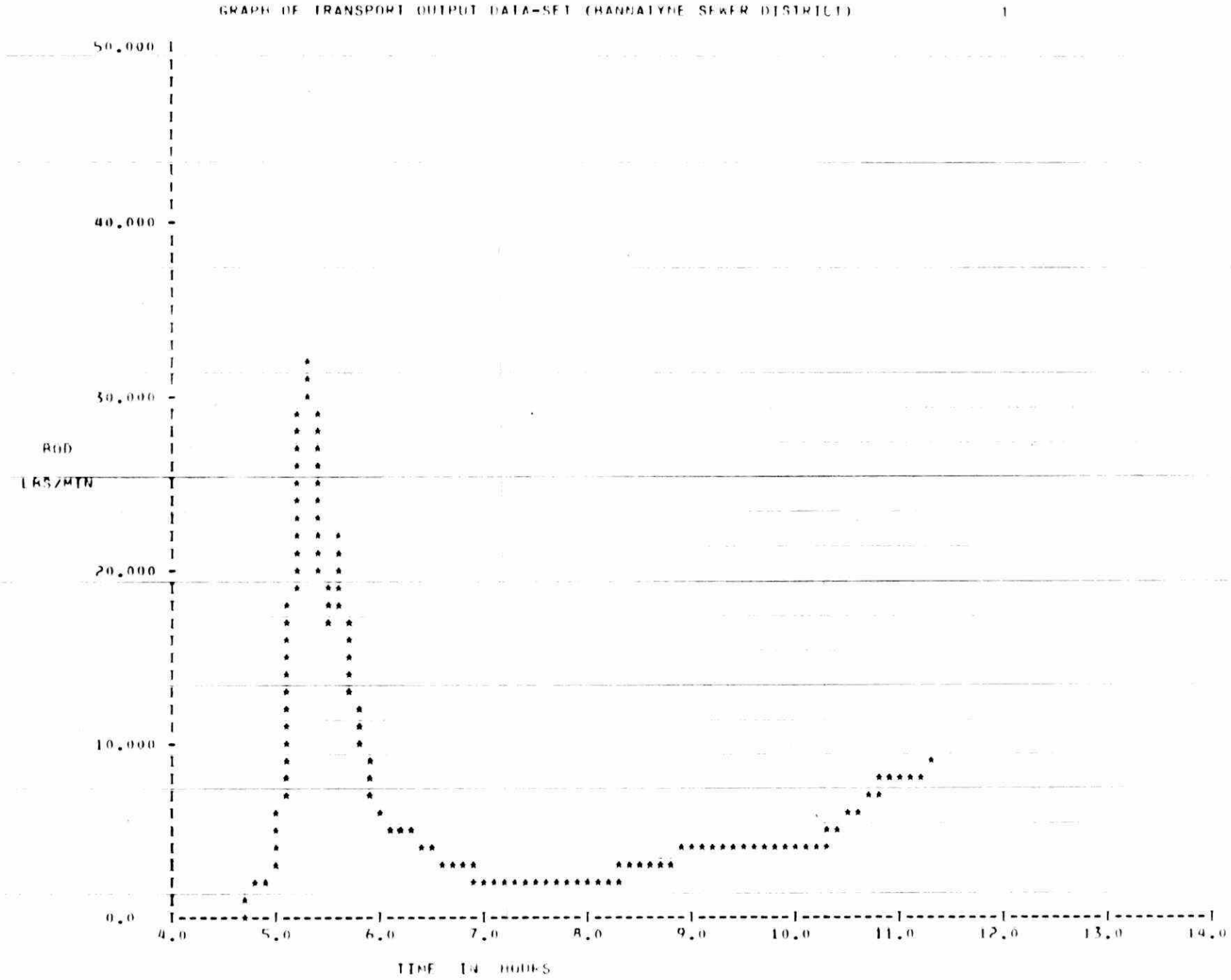


FIGURE 16. OUTFALL POLLUTOGRAPH FOR BOD

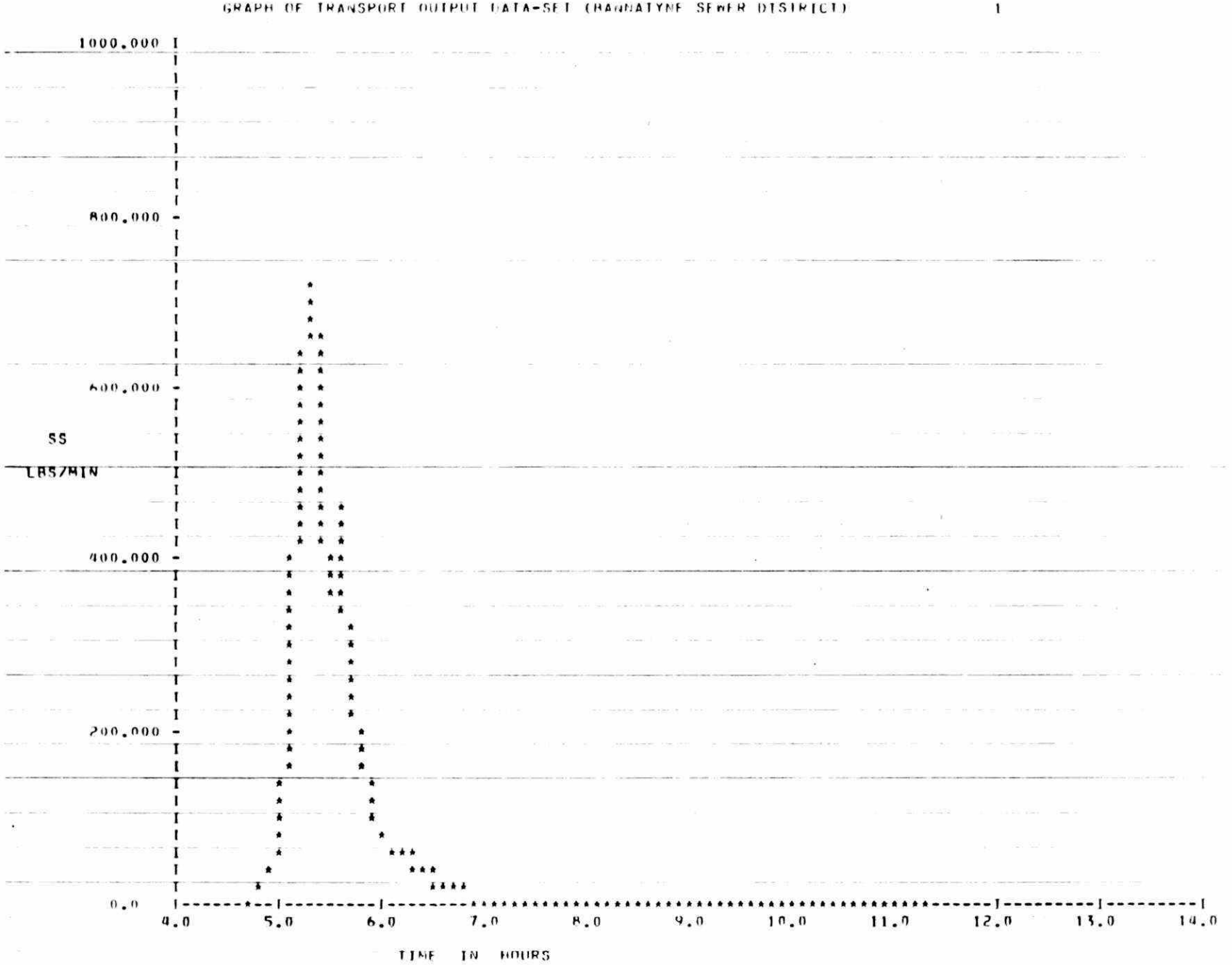


FIGURE 17. OUTFLOW POLLUTOGRAPH FOR SUSPENDED SOLIDS

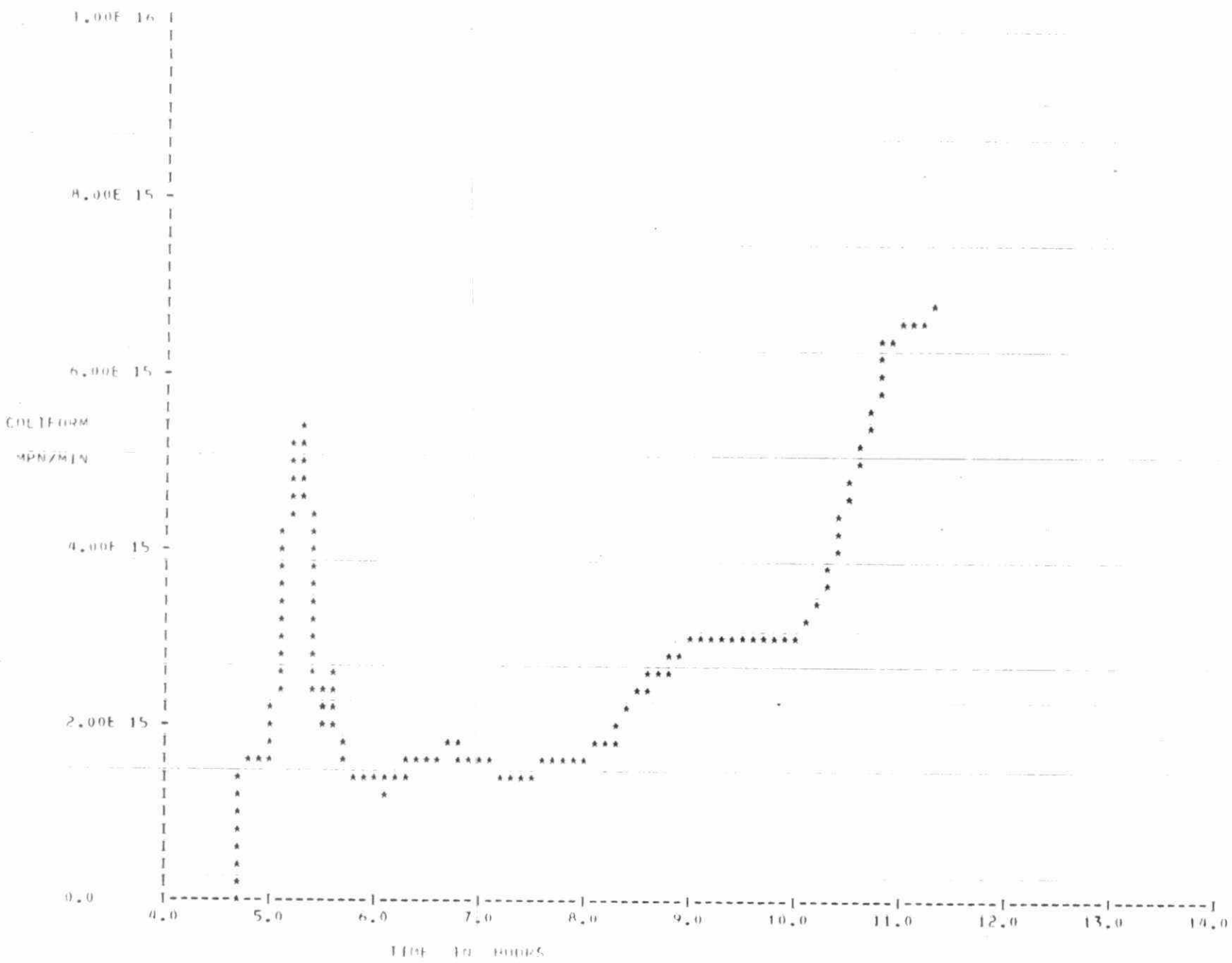


FIGURE 18. OUTFLOW POLLUTOGRAPH FOR COLIFORMS

6. STORAGE/TREATMENT BLOCK

6.1 Introduction

The routing of flow through the STORAGE/TREATMENT Block is controlled by subroutine STORAG which is called from the EXECUTIVE Block. STORAG coordinates the sewage quantities and qualities, the specifications of storage and treatment facilities to be modelled, and the estimation of costs. The FORTRAN program is about 3,700 lines in length, comprising 16 subroutines. The relationships among the subroutines which comprise the STORAGE/TREATMENT Block are shown in Figure 19.

This section describes features in the Canadian version of SWMM which are not available in the EPA Version II SWMM. Since the changes are internal to the program, they have no effect on the input data. Reference to EPA SWMM Version II User's Manual should be made for a more detailed discussion of the parameters used in applications of the model.

6.2 Changes to the Model

6.2.1 Storage simulation routines (STORAG)

The EPA Version II SWMM recirculated any flow that discharged out of the storage basin which could not be accepted by the treatment routine, back into the storage basin. In normal installations, fixed speed pumps, orifices, or weirs are used to control the release of water from a storage basin, and these units generally have no capacity for variable demands. This "recirculation" system was removed from the Canadian version of SWMM such that any flows that the treatment routine cannot accept are by-passed to the receiving water body. The model provides the capability of chlorinating this by-passed flow.

In the Canadian version of SWMM, the decay of SS and BOD concentrations utilize a "mass balance" approach which is considered to be more representative of the real flow phenomena. The exponential decay function in the EPA Version II was deleted.

In the Canadian Version of SWMM, the removal efficiency of SS was adjusted to reflect the work of Smith (1971)*.

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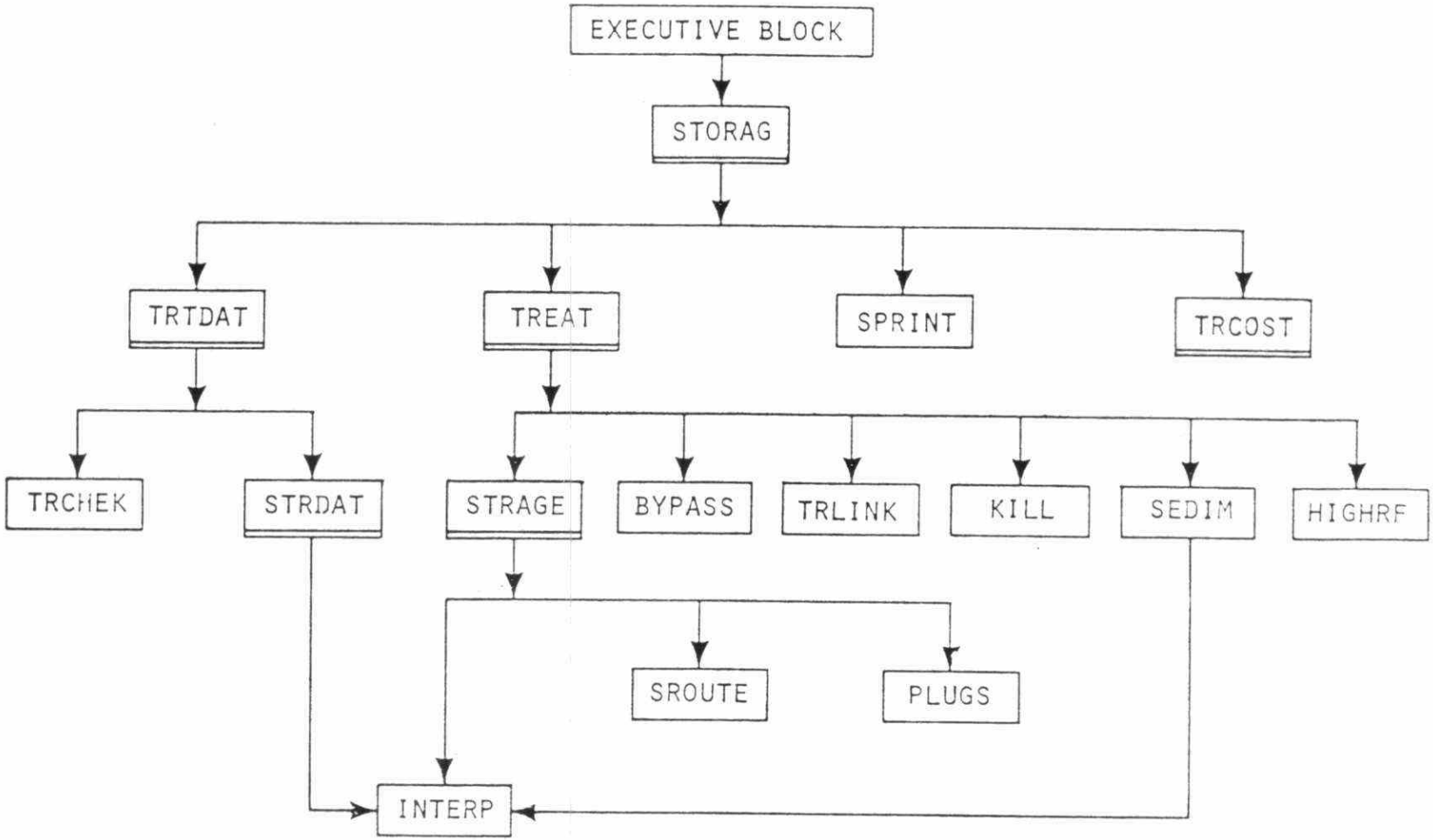
* See Volume I of this study, Canada-Ontario Agreement Research Report No. 47.



NOTE: BOXES WITH DOUBLE UNDERLINE REPRESENT MAJOR SUBROUTINES.

FIGURE 19. STORAGE BLOCK

6.2.2 Treatment simulation routines (TREAT)

The Canadian version of SWMM includes consideration of the underflow for the operation of the swirl concentrator. For simulations of the performance of this treatment unit, an underflow rate equal to 1/70 of the inflow to the unit was added.

In the Canadian version of SWMM, the percent removal of SS for fine screens was changed to 35%. Recent information released by Metcalf and Eddy (1971)* indicated that the original 22% removal was not realistic. This change significantly increased the cost effectiveness of fine screens and increased their importance as a treatment alternative.

As discussed in Section 7 of Volume II, "Treatment Processes", the removal of BOD due to chlorination is dubious. The Canadian version of SWMM deletes this mode of pollutant removal from the model.

6.2.3 Cost estimation routines

Table 34 presents a summary of the capital cost functions for the individual treatment options incorporated in the Canadian version of SWMM.

It is assumed that the cost function for all treatments may be represented by the following general equation:

$$S = AQ^{B}F \qquad (1)$$

where: A = base cost factor,
Q = design flow rate through the unit (in mgd),
B = indicator of the economy of scale,
F = correction factor for locality and year.

Cost curves and equations were developed using publications from the Ontario Ministry of the Environment, the U.S. Environmental Protection Agency, bid construction costs for sewage treatment plants (over a range of 1.2 - 24 MIGD), and estimations from equipment manufacturers. These costs include such considerations as electrical work, yard piping, roads, equipment and other associated activities.

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* See Volume I of this study, Canada-Ontario Agreement Research Report No. 47

TABLE 34. CAPITAL COST FUNCTION

Treatment Options		Cost Functions
1.	Bar Screen	$40400\ Q^{0.61}\ F$
2.	Swirl Concentrator	3330 Dia. F
3.	Inlet Pumping	$58500\ Q^{0.84}\ F$
4.	Dissolved Air Flotation	$110000\ [Q \times (1+RECIRC.)]^{0.43} F$ $Q \leq 10$ MGD $35600\ [Q \times (1+RECIRC.)]^{0.92} F$ $Q > 10$ MGD
5.	Fine Screens	18570 QF
6.	Sedimentation Tanks	$5840000\ (Q/R)^{0.55}$
7.	Microstrainer	$67000\ Q^{0.46}\ F$ $Q \leq 20$ MGD $27275\ Q^{0.76}\ F$ $Q > 20$ MGD
8.	High Rate Filters	$56000\ Q^{0.80}\ F$
9.	Biological Treatment	$1400000\ Q^{0.69}\ F$
10.	Effluent Screens	$11200\ Q^{0.56}\ F$
11.	Outlet Pumping	$58500\ Q^{0.84}\ F$
12.	Chlorine Contact Tank	$28100\ Q^{0.60}\ F$
13.	High Rate Disinfection	$3070\ Q^{1.0}\ F$

ENR Index = 2033
F = 1.0

Finally, the use of a construction cost index for adjustment of cost on a common basis is of utmost importance. Presently, the model uses the ENR Index as published in the Engineering New Record Magazine.

6.2.4 General changes

Figure 20 presents all storage and treatment options available in the Canadian version of SWMM. The EPA version excluded the additional storage option (Level 03) on the corresponding diagram in the EPA User's Manual.

Further information on the changes made to the STORAGE/TREATMENT Block is given in Section 7 of the Final Report, Volume I of this study.

The input data for this Block are identical to that of the EPA SWMM Version II, and are shown on Figure 21 and Tables 35 and 36.

6.3 Example Application

A continuation of the Bannatyne simulation carried out in the RUNOFF and TRANSPORT sections of this report is presented as an example of the STORAGE/TREATMENT Block. The outflow hydrograph and pollutographs at Manhole 1 produced by the TRANSPORT Block in the previous section are used as input. This example simulated an in-line storage facility (sedimentation), bar racks, swirl concentrator, microstrainers, and a chlorine contact tank.

Table 37 shows the input data used in this simulation. The numbers in parentheses to the left of each line of data refer to the card group number used in Table 35 to describe the data formats.

The first two cards identify the outfall location (element 1), the number of complete runs through the program desired (1) and the ratio of maximum flow to be treated to the maximum flow arriving (1). The third and fourth cards identify the sequence of the treatment options and print control options. The fifth and sixth cards describe the input data for the swirl concentrator. The next six cards specify the geometry and design parameters for the storage unit. The next card is the cost data card for storage excavation. The value of CPCUYD (unit cost of excavation) on the card has been set at $20. The next card specifies the clock time of start of storm. The last four cards describe the input cost functions.

Table 38 shows basic control information which was read from the TRANSPORT Block input file. The input hydrograph was produced for the outfall (element 1) in the previous section.

Table 39 shows more control information supplied as input by the TRANSPORT output file and by the input cards listed in Table 37. The selected treatment options have been listed, and the design flow rate selected based upon the incoming hydrograph peak ordinate. Geometric input data on the storage facility, its size, and outlet control has been printed. The remainder of Tables 39 and 40 show additional information on the selected treatment options (either supplied or estimated by the program based upon the maximum flow rate).

Table 41 shows the step-by-step output results after each time interval. Both the treatment and storage options are printed out. The initial filling of the storage unit and subsequent controlled inflow to the treatment facility, at which point pollutant removals have been computed, can be observed in this table.

Table 42 shows a summary of the treatment performance both for the total package and also for each level.

Table 43 shows the input unit costs and cost estimation parameters, and also the output estimates for capital, annual and operating costs for this storage/treatment facility.

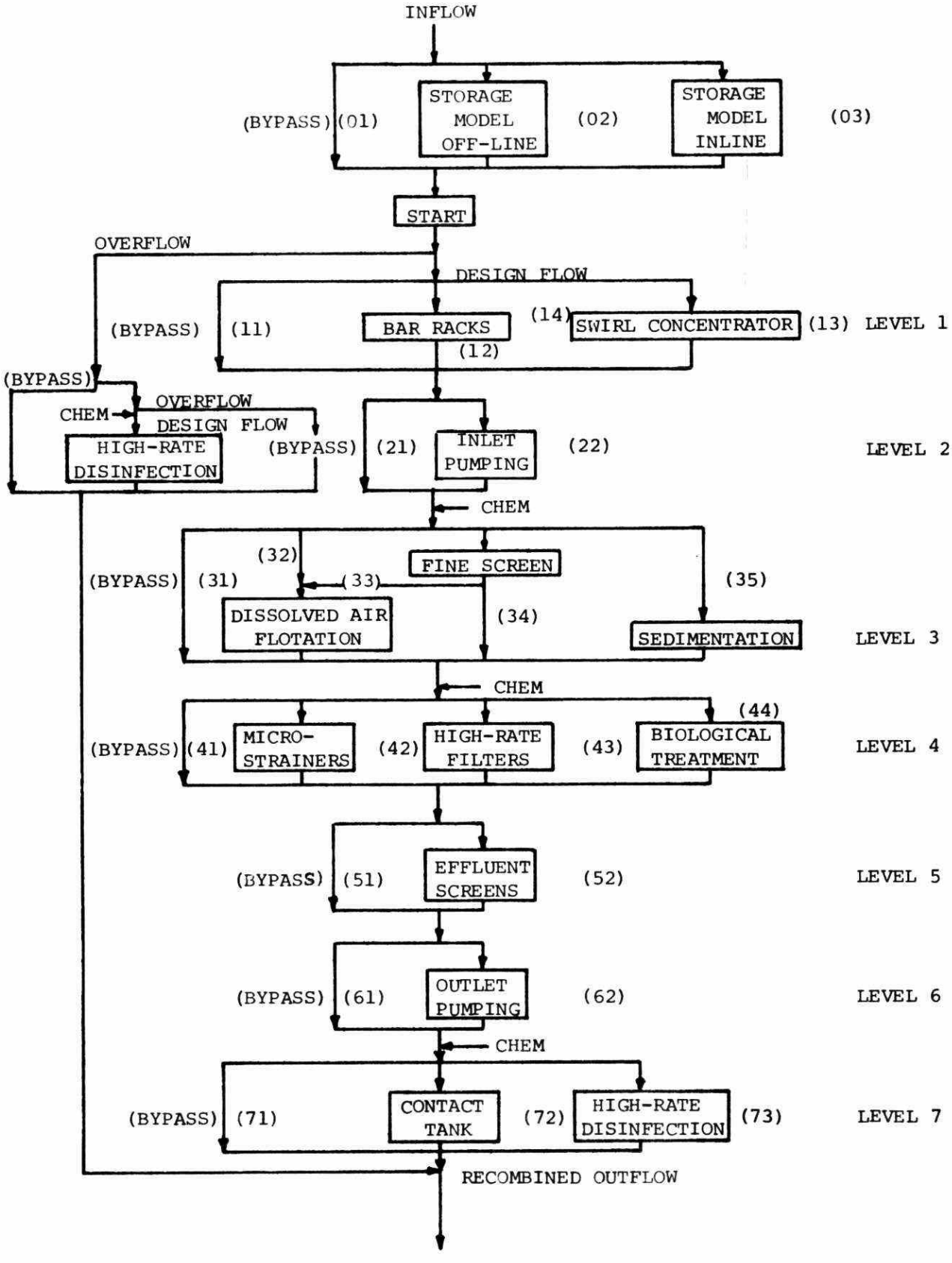

FIGURE 20. OPTIONS AVAILABLE IN REVISED TREATMENT MODEL

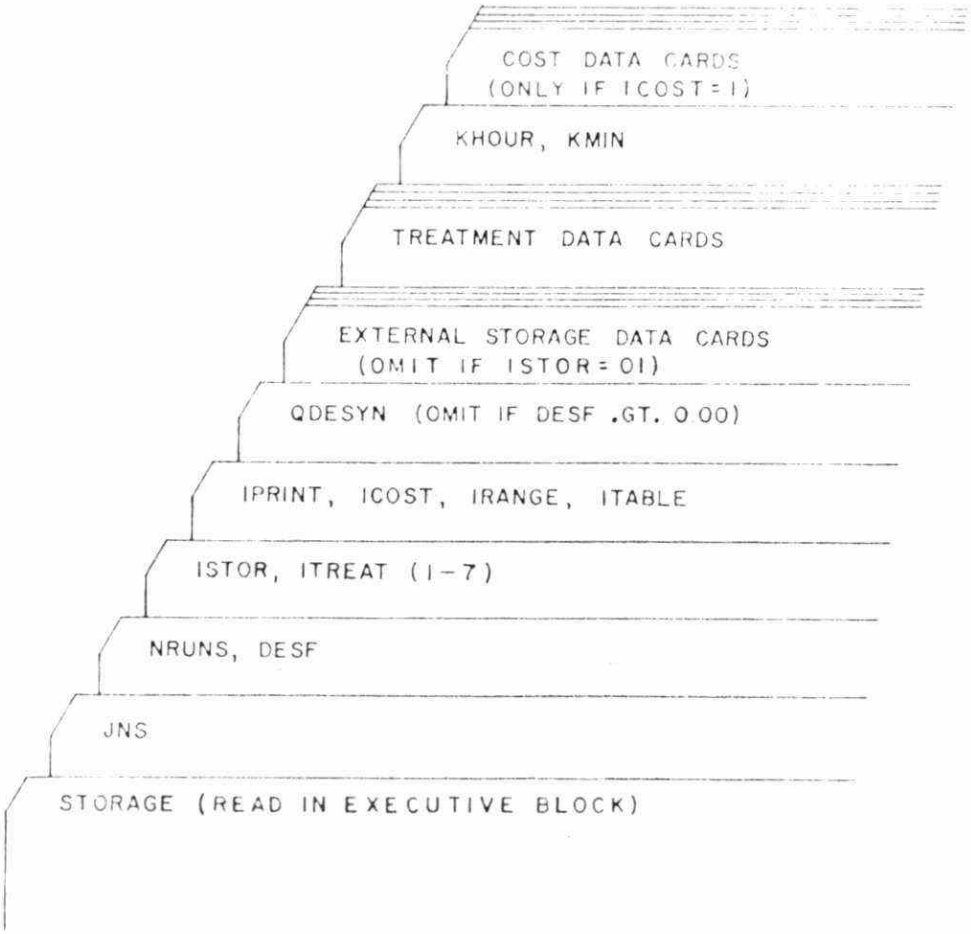

FIGURE 21. DATA DECK FOR STORAGE BLOCK

TABLE 35. STORAGE BLOCK CARD DATA

Card group	Format	Card column	Description	Variable name	Default value
1	I10	1-10	External element numbers from the Transport Block (NOUTS) which route the flow to the Storage Block (maximum = 1 for each run).	JNS	None
2			Execution control data.		
	I10	1-10	Number of different treatment executions to be made on the output from the Transport Block, element JNS	NRUNS	None
	F10.2	11-20	The ratio of the maximum flow to be treated to the maximum flow arriving (if unknown leave blank and include Card Group 5).	DESF	QDESYN
	F10.2	21-30	Design flow for high-rate disinfection for overflows, cfs.	QDHIGH	0.0
	I10	31-40	High-rate disinfection for overflow. = 0, No, = 1, Yes.	IQDHO	0
3			Treatment control data.		
	I615	1-5	Parameter indicating if external storage is to be called. ISTOR = 1, External storage not called, ISTOR = 2, External storage called. Inflow, (up to treatment capacity) bypasses storage directly to treatment. ISTOR = 3, External storage called. All inflow is routed to storage prior to treatment.	ISTOR	1
		6-10	Bar racks and swirl concentrator (level 1).	ITREAT(1)	11

TABLE 35. (CONT'D)

Card group	Format	Card column	Description	Variable name	Default value
			= 11, Bar racks and swirl concentrator bypassed,		
			= 12, Bar racks are in waste stream,		
			= 13, Swirl concentrator is in waste stream,		
			= 14, Bar racks followed by swirl concentrator are in waste stream.		
		11-15	Inlet pumping parameter (level 2).	ITREAT(2)	21
			= 21, No pump station,		
			= 22, Pump station exists.		
		16-20	Primary treatment parameter (level 3).	ITREAT(3)	31
			= 31, No primary treatment (flow bypassed),		
			= 32, Dissolved air flotation,		
			= 33, Fine screens and dissolved air flotation,		
			= 34, Fine screens only,		
			= 35, Sedimentation.		
		21-25	Secondary treatment parameter (level 4).	ITREAT(4)	41
			= 41, No secondary treatment (flow bypassed),		
			= 42, Microstrainers,		
			= 43, High rate filter,		
			= 44, Biological treatment.		
		26-30	Effluent screens (level 5).	ITREAT(5)	51
			= 51, No screens,		
			= 52, Effluent screens.		

TABLE 35. (CONT'D)

Card group	Format	Card column	Description	Variable name	Default value
		31-35	Outlet pumping parameter (level 6).	ITREAT(6)	61
			= 61, No pumping,		
			= 62, pumping required.		
		36-40	Chlorine contact tank or high-rate disinfection (level 7).	ITREAT(7)	71
			= 71, No chlorine contact tank or high-rate disinfection (flow bypassed),		
			= 72, Chlorine contact tank,		
			= 73, High-rate disinfection.		
4			Computation print control card.		
	4I10	1-10	Printout of treatment results for each time step.	IPRINT	0
			= 0, Printout for each time step suppressed,		
			= 1, Printout quantity results for each time step,		
			= 2, Printout quality results for each time step.		
		11-20	Cost control data.	ICOST	0
			= 0, Cost calculations and the resulting printout are suppressed,		
			= 1, Compute costs and print cost summary.		
		21-30	Flow quantities summarization control parameter.	IRANGE	0
			= 0, Flow quantity range not summarized,		
			= 1, Quantity ranges summarized.		

TABLE 35. (CONT'D)

Card group	Format	Card column	Description	Variable name	Default value
		31-40	Control of tabular output of the inlet and outlet flows from the treatment model. - 0, Flows not summarized in tabular form, - 1, Flows summarized in tabular form.	ITABLE	0
			IF DESF IN CARD GROUP 2 IS ZERO INCLUDE CARD GROUP 5, OTHERWISE OMIT.		
5	F10.2	1-10	Design flow rate of treatment facilities, cfs.	QDESYN	None
			IF TREAT(1) ≠ 13 OR 14, SKIP CARDS 6 AND 7.		
6			Swirl concentrator data.		
	I10	1-10	Number of particles sizes (maximum number = 9).	NOPART	None
	2F10.0	11-20	Swirl concentrator diameter, ft.	DIAMSP	None
		21-30	Specific gravity of particles.	SPGRAV	None
7			Swirl concentrator particle size data card.		
	16F5.0	1-5	Particle size, cm.	PSIZE(1)	None
		6-10	Fraction of total particles.[a]	PCENT(1)	None
		11-15	Particle size, cm.	PSIZE(2)	None

[a]All values of PCENT are entered as fractions.

TABLE 35. (CONT'D)

Card group	Format	Card column	Description	Variable name	Default value
			Fraction of total particles	PCENT(2)	None
			.	.	
			.	.	
			.	.	
			Particle size, cm.	PSIZE(NOPART)	None
			Fraction of total particles	PCENT(NOPART)	None
			CARDS 8 THROUGH 17 ARE DATA INPUT FOR EXTERNAL STORAGE. (ISTOR = 2 ON CARD 3). OMIT THESE DATA CARDS IF EXTERNAL STORAGE IS NOT DESIRED.		
8			Storage unit data card.		
	10I5	1-5	Storage mode parameter.	ISTMOD	1
			= 1, In-line storage.		
		6-10	Storage type parameter.	ISTTYP	1
			= 1, Irregular (natural) reservoir,		
			= 2, Geometric (regular) covered reservoir,		
			= 3, Geometric (regular) uncovered reservoir.		
		11-15	Storage outlet control parameter.	ISTOUT	1
			= 1, Gravity with orifice center line at zero storage tank depth,		
			= 2, Gravity with fixed weir,		
			= 5, Dual rate pumps[a],		
			= 6, Existing fixed-rate pumps,		
			= 9, Gravity with both weir and orifice.[b]		

[a] Second pump starts if first pump does not lower water level.

[b] This type of storage outlet is not presently programmed, if modelling is desired, use internal storage from Transport Block.

TABLE 35. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
9			Computation/print control card.		
	3I10	1-10	Basin flow parameter. = 0, No pollutants, (hydraulics only), = 1, Perfect plug flow through basin, = 2, Perfect mixing in basin.	IPOL	0
		11-20	Print control parameter. = 0, No print each time step, = 1, Print each time step in storage.	ISPRIN	0
10			Reservoir flood depth data card.		
	F10.2	1-10	Maximum (flooding) reservoir depth, ft.	DEPMAX	None
	I10	11-20	Chlorination option.[a]	ICL2	None
			INCLUDE EITHER CARD GROUP 11 OR 12, NOT BOTH.		
			INCLUDE CARD GROUP 11 IF ISTTYP ON CARD 8 HAS THE VALUE 1.		
11			Reservoir depth-area data card.		
	F10.2	1-10	A reservoir water depth, ft.	ADEPTH(1)	None
	F10.0	11-20	Reservoir surface area corresponding to above depth, ft^2.	AASURF(2)	None
		.		.	
		.		.	
		.		.	
		.		.	
	F10.2	61-70	A reservoir water depth, ft.	ADEPTH(4)	None

[a] Not presently programmed, leave blank.

TABLE 35. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
	F10.0	71-80	Reservoir surface area corresponding to above depth, ft^2.	AASURF(4)	None
			(NOTE: The above pair of variables is repeated 11 times, 4 pairs per card.)		
			INCLUDE CARD 12 ONLY IF ISTTYP ON CARD 8 HAS THE VALUE 2 OR 3.		
12			Reservoir dimensions data card.		
	2F10.0	1-10	Reservoir base area, ft^2.	BASEA	None
		11-20	Reservoir base circumference, ft.	BASEC	None
	F10.5	21-30	Cotan of sideslope (horizontal/vertical).	COTSLO	None
			INCLUDE ONLY ONE OF THE OUTLET DATA CARDS 13, 14 OR 15.		
			INCLUDE CARD 13 ONLY IF ISTOUT ON CARD 8 HAS THE VALUE 1.		
13			Orifice outlet data card.		
	F10.3	1-10	Orifice outlet area x discharge coefficient, ft^2.	CDAOUT	None
			INCLUDE CARD 14 ONLY IF ISTOUT ON CARD 8 HAS THE VALUE 2.		
14			Weir outlet data card.		
	2F10.3	1-10	Weir height above depth = 0, ft.	WEIRHT	None
		11-20	Weir length, ft.	WEIRL	None

TABLE 35. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
			INCLUDE CARD 15 ONLY IF ISTOUT ON CARD 8 HAS THE VALUE 5 OR 6.		
15			Pump outlet data card.		
	3F10.3	1-10	Outflow pumping rate,[a] cfs.	QPUMP	None
		11-20	Depth at pump startup, ft.	DSTART	None
		21-30	Depth at pump shutdown, ft. (DSTOP > 0.0)[b]	DSTOP	None
16			Initial conditions data card.		
	2F10.2	1-10	Storage at time zero, ft^3.	STORO	0.0
		11-20	Outflow rate at time zero, cfs.	QUOTO	0.0
17			Cost data card.		
	F10.2	1-10	$/$yard^3$ for storage excavation.	CPCUYD	0.0
			END OF EXTERNAL STORAGE CARDS.		
			IF ITREAT(2) = 22 ON CARD 3, INCLUDE CARD 18.		
18	F10.2	1-10	Pump head for inlet lift station of the treatment facilities, ft.	HEAD1	None
			INCLUDE ONLY ONE OF THE LEVEL 3 TREATMENT CARDS 19 OR 20 IF ITREAT(3) IS NOT EQUAL TO 31 OR 34 ON CARD 3.		
			INCLUDE CARD 19 ONLY IF ITREAT(3) ON CARD 3 HAS THE VALUE OF 32 OR 33.		

[a]Pumping rate is for a single pump. Dual pumping (ISTOUT = 5) doubles this rate when second pump is on.

[b]DSTOP must equal or be greater than the level in storage that contains enough volume to handle the pumping rate, QPUMP, for one time step.

TABLE 35. (CONT'D)

Card group	Format	columns	Description	Variable name	Default value
19			Dissolved air flotation data cards.		
	2I5	1-5	Chemical addition to the unit.	ICHEM	0
			= 0, No chemical addition,		
			= 1, Chemical addition.		
		6-10	Chlorine addition to the unit.	ICL2	0
			= 0, No chlorine addition,		
			= 1, Chlorine addition.		
	3F10.2	11-20	Design overflow rate, gal/day/ft^2. (5,000.0 suggested).	OVRDAF	None
		21-30	Amount of flow recirculation, percent (15% suggested).	RECIRC	None
		31-40	Depth of dissolved air flotation tank, ft.	DEEP	None
			INCLUDE CARD 20 IF ITREAT(3) = 35 AND ISTOR = 1 ON CARD 3.		
20			Primary sedimentation tank cards.		
	2F10.2	1-10	Primary sedimentation tank overflow rate, gal/day/ft^2 (1,000.0 suggested).	OVRSED	None
		11-20	Depth of sedimentation tank, ft (8.0 suggested).	SEDEP	None
	I10	21-30	Chlorine addition to unit.	ICL2	0
			= 0, No chlorine addition,		
			= 1, Chlorine addition.		
			INCLUDE CARD 21 ONLY IF ITREAT(4) = 43 ON CARD 3.		
21			High rate filter data cards.		

TABLE 35. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
	F10.2	1-10	Maximum operating rate of the filter, gal/min/ft^2.	OPRAMA	None
	I10	11-20	Addition of chemicals.	ICHEMH	0
			= 0, No chemicals added,		
			= 1, Chemicals added.		
	2F10.2	21-30	Maximum design head loss of filter, ft.	HM	None
		31-40	Maximum solids holding capacity at maximum head and maximum flow rate, lb/ft^2.	SQM	None
			INCLUDE CARD 22 ONLY IF ITREAT(6) = 62 ON CARD 3.		
22	F10.2	1-10	Pump head for outflow lift station from treatment facilities, ft.	HEAD2	None
			END OF TREATMENT CARDS.		
23			Time for start of treatment-storage simulation.		
	2I5	1-5	Hour of start, 24 hour clock.	KHOUR	0
		6-10	Minute of start, min.	KMIN	0
			INCLUDE CARDS 24 THROUGH 26 ONLY IF ICOST = 1 ON CARD 4.		
24			ENR cost data.		
	F10.2	1-10	Amortization interest rate for construction of treatment facilities, percent.	RATEPC	7.0
	2I10	11-20	Amortization period, yr.	NYRS	25

TABLE 35. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
		21-30	Year of computer simulation (minimum = 1970, maximum = 1980).	MMDDYR	None
	F10.4	31-40	ENR factor for the geographic location of treatment facilities.	SITEF	1.0
25			ENR cost index for year and location.	IENR	
	8I10	1-10	ENR for 1970.	IENR(1)	None
		11-20	ENR for 1971.	IENR(2)	None
		.		.	
		.		.	
		.		.	
		71-80	ENR for 1977.	IENR(8)	None
		.		.	
		.		.	
		.		.	
		21-30	ENR for 1980.	IENR(11)	None
26			Unit cost data card.		
	F10.0	1-10	Unit cost of land, $/acre.	UCLAND	20000.0
	F10.5	11-20	Unit cost of power, $/KWH.	UCPOWR	0.02
	3F10.2	21-30	Unit cost of chlorine, $/lb.	UCCL2	0.20
		31-40	Unit cost of polymers, $/lb.	UCPOLY	1.25
		41-50	Unit cost of alum, $/lb.	UCALUM	0.03
			END OF STORAGE BLOCK CARDS.		

TABLE 36. STORAGE/TREATMENT VARIABLES

Variable Name	C*	Description	Unit
AASURF	C	Surface area of natural reservoir	sq ft
ADEPTH	C	Depth of reservoir	ft
ADJ		Dummy variable	
ALACST		Amortized cost of land required	$/yr
ALAND		Area of land required for this equipment	acres
ALANDT		Total area of land required for the equipment	acres
ALASC		Amortized cost of land required for screens	$/yr
ALCSTT		Total amortized cost of land required	$/yr
ALSC		Area of land required for screens	acres
ALUMUH		Alum used for high rate filter	lb
ALUMUT	C	Total alum used	lb
ANCSTT		Total amortized cost of installed equipment	$/yr
ANNSC		Amortized cost of screens	$/yr
ANNTOT		Total amortization cost including land and equipment	$
AO2DT2	C	Volume of outflow per half time-step	cf
APLAN	C	Land area requirement	sq ft
AREA		Surface area of man-made storage unit	sq ft
AREA1		Surface area for preceding time-step	sq ft
AREA2		Surface area for present time-step	sq ft
AREAMS	C	Submerged screen area	sq ft/unit
ATERM	C	Volume in storage plus outflow	cf
BACK		Back flow volume	cf
BASEA		Base area of reservoir	sq ft
BASEC		Base circumference of reservoir	ft
BASICM		Cost of minimum maintenance (no storm)	$/yr
BCIF		BOD concentration of inflow	mg/L
BCIFMN		Minimum BOD concentration of the inflow	mg/L
BCIFMX		Maximum concentration of BOD of inflow to the whole model	mg/L
BCIFT		Accumulative total or arithmetic average of BOD concentration of the inflow to the whole model	mg/L
BCIN	C	BOD inflow rate to one treatment unit	lb/DT
BCINMN		Minimum BOD concentration of the inflow	mg/L
BCINMX		Maximum BOD concentration of the inflow	mg/L
BCINT		Accumulative total or arithmetic average of BOD concentration of inflow to one treatment unit	mg/L
BCOF		BOD concentration in the bypass (overflow)	mg/L
BCOFMN		Minimum BOD concentration of the bypass (overflow)	mg/L
BCOFMX		Maximum BOD concentration of overflow	mg/L
BCOFT		Accumulative total or average of BOD concentration of the overflow	mg/L
BCOU	C	BOD concentration of outflow from one treatment unit per time-step	mg/L

[a]Does not include variables added during updating.
*Variable names shared in common blocks.

TABLE 36. (CONT'D)

Variable Name	C*	Description	Unit
BCOUFT		BOD concentration of outflow	mg/L
BCOUMN	C	Minimum BOD concentration of the outflow	mg/L
BCOUMX	C	Maximum concentration of BOD of outflow	mg/L
BCOUS		BOD concentration in the outflow from screens	mg/L
BCOUT	C	Accumulative total or arithmetic average of BOD concentration of outflow from one treatment level	mg/L
BCREDU		BOD concentration reduced	mg/L
BCRL		BOD concentration of the released flow per time-step	mg/L
BCRLMN		Minimum BOD concentration of the released flow	mg/L
BCRLMX		Maximum BOD concentration of the released flow	mg/L
BCRLT		Accumulated total or arithmetic average at BOD concentration of the released flow	mg/L
BCRM	C	BOD concentration of the waste flows from individual treatment unit	mg/L
BCRMMN	C	Minimum BOD concentration removed	mg/L
BCRMMX	C	Maximum BOD concentration removed	mg/L
BCRMT	C	Accumulative total for arithmetic average of BOD concentration of the wasted flows from one treatment unit	mg/L
BCRM1		BOD concentration of the waste flows from individual treatment unit	mg/L
BDARR	C	Outfall BOD	lb
BDCIF		BOD concentration of inflow (= BCIF)	mg/L
BDCRL		BOD concentration of released flow = BCRL	mg/L
BDEPTH	C	Water depth	ft
BDIF	C	Total BOD in the inflow to the whole model	lb
BDIFRF		Fraction of BOD removed to BOD flowing into whole model	
BDIFT		Accumulative total BOD of the inflow	lb
BDIN	C	BOD inflow rate to one treatment unit	lb/DT
BDINRF		Fraction of BOD removed to BOD flowing into each treatment unit	
BDINT	C	Accumulative total BOD flow into one treatment unit	lb
BDOF		BOD rate in bypassed waste flows	lb/DT
BDOFT		Accumulative total BOD in the overflows	lb
BDOU	C	BOD outflow rate	lb/DT
BDOUS		BOD outflow rate from screens	lb/DT
BDOUT	C	Accumulative total BOD flow out of one treatment unit	lb
BDRD		BOD reduction, percentage	%
BDRL	C	BOD released per time-step	lb/DT
BDRLT		Accumulative total BOD released from the whole model	lb
BDRM	C	BOD removal per time-step	lb/DT
BDRMT	C	Accumulative total BOD removal by one treatment unit	lb
BDRMIT		Accumulative total BOD removed by the whole model	lb

TABLE 36. (CONT'D)

Variable Name	C*	Description	Unit
BDRS		BOD removed by screens per time-step	lb/DT
BDRST		Total BOD removed by screens	lb
BIG	C	Initializing number, (10^{12})	
BMSC		Basic maintenance cost of fine screens	$/storm
BODCOT		BOD outflow concentration	mg/L
BODIN	C	BOD inflow rate (pollutograph)	lb/DT
BODOUT	C	BOD outflow	lb
BREFF		BOD removal efficiency	
BREFFH	C	BOD removal efficiency of high rate filter	
BREFF2		BOD removal efficiency	
BSICMT		Total minimum maintenance cost	$
BSTOR	C	Storage	cf
BYPASS		Name of subroutine	
CAPCST		Capital cost of installed equipment	$
CAPMS		Capacity per microstrainer unit	mgd
CAPSC		Capital cost of screens	$
CAPST		Capital cost for five screens	$
CAPTOT		Total capital costs including land and equipment	$
CAPUCL		Dosing rate per trickling filter unit	lb/day
CCIF		Coliform concentration of inflow to whole model	MPN/100 ml
CCIFMN		Minimum coliform concentration of the inflow	MPN/100 ml

Variable Name	C*	Description	Unit
CCIFMX		Maximum coliform concentration of inflow	MPN/100 ml
CCIFT		Accumulative total for arithmetic average of coliform concentration of inflow	MPN/100 ml
CCIN		Coliform concentration of the inflow to one treatment unit	MPN/100 ml
CCINMN		Minimum coliform concentration of the inflow to one unit	MPN/100 ml
CCINMX		Maximum coliform concentration of the inflow to one unit	MPN/100 ml
CCINT		Accumulative total or arithmetic average of coliform concentration of the inflow to one treatment level	MPN/100 ml
CCOF		Coliform concentration in the overflow	MPN/100 ml
CCOFMN		Minimum coliform concentration of the overflow	MPN/100 ml
CCOFMX		Maximum coliform concentration of overflow	MPN/100 ml
CCOFT		Accumulative total for arithmetic average of coliform concentration of the overflow	MPN/100 ml
CCOU		Coliform concentration of the outflow during one time-step	MPN/100 ml
CCOUMN		Minimum coliform concentration of the outflows	MPN/100 ml
CCOUMX		Maximum coliform concentration of the outflow	MPN/100 ml
CCOUT		Accumulative total for arithmetic average of the outflow coliform concentration	MPN/100 ml
CCRL		Coliform concentration of the released flow per time-step	MPN/100 ml
CCRLMN		Minimum coliform concentration of the released flow	MPN/100 ml

TABLE 36. (CONT'D)

Variable Name	C*	Description	Unit
CCRLMX		Maximum coliform concentration of the released flow	MPN/100 ml
CCRLT		Accumulative total or arithmetic average of coliform concentration of the released flow	MPN/100 ml
CDAOUT		Outlet orifice area times discharge coefficient	sq ft
CFSOF		Overflow rate for microstrainer	cfs
CFSTR		Internal bypass flow treated by microstrainer	cfs
CFSTR2		Effluent flow from microstrainer	cfs
CHCOST		Chemical cost, per process	$/storm
CHCSTT		Total chemical costs	$/storm
CHEMU		Chemical use per time-step and process	lb
CHEMUH		Chemical used for high rate filter	lb
CHEMUT	C	Total chemicals use per unit	lb
CLACST		Capital cost of land required	$
CLAND	C	Cost of lands	$
CLASC		Cost of land for screens	$
CLCSTT		Total capital cost of land requirement	$
CL2CST	C	Cost of chlorine used	$/storm
CL2DEM		Chlorine demand	mg/L
CL2U		Chlorine used per time-step	lb
CL2UC		Chlorine used	lb/day
CL2UT	C	Total chlorine used	lb/day
CL2UTT		Total chlorine used for whole model	lb
COARR	C	Outfall coliform	MPN
COCIF		Coliform concentration of inflow (= CCIF)	MPN/100 ml
COCRL		Coliform concentration of released flow (= CCRL)	MPN/100 ml
COIF	C	Coliform inflow rate for Storage Model	MPN/DT
COIFRF		Fraction of coliform removed to coliform flowing into the whole model	
COIFT		Accumulative total coliform inflow	MPN
COIN		Coliform inflow rate to one treatment unit	MPN/DT
COINRF		Fraction of coliform removed to coliform flowing into each treatment unit	
COINT		Accumulative total coliform flowing into one treatment unit	MPN
COLCOT		Coliform outflow	MPN/100 ml
COLIFT		Total coliform flowing into whole model	MPN
COLIN	C	Coliform inflow rate (pollutograph)	MPN/DT
COLOUT	C	Coliform outflow	MPN/DT
CONVER	C	Conversion factor 10^6/DT sec lbs/cf	mg/L/lb/cfs
CONVOL		Volume of contact tank	cf
COOF		Number of coliform per time-step in the overflow	MPN/DT
COOFT		Accumulative total coliform in the overflow	MPN
COOU		Coliform outflow from one treatment unit per time-step	MPN/DT

TABLE 36. (CONT'D)

Variable Name	C*	Description	Unit
COOUT		Accumulative total coliform flowing out of one treatment unit	MPN
CORD		Coliform reduction, percentage	%
CORL	C	Coliform released per time-step	MPN/DT
CORLT		Accumulative total coliform released	MPN
CORM		Coliform removed from treatment	MPN/DT
CORMT		Accumulative total coliform removed by one treatment unit	MPN
COTSLO		Contangent of side slope angle	
CPACRE	C	Cost per acre of land	$/acre
CPCSTT		Total capital cost of installed equipment	$
CPCUYD	C	Unit cost of excavation	$/cy
CPS	C	Capital cost of pump station for storage	$
CRC		Computational variable for CRF	
CRF		Capital recovery factor	
CSTOR	C	Cost of storage	$
CTOTAL	C	Total cost	$
CUMIN	C	Cumulative inflow since start of simulation	cf
CUMOUT	C	Cumulative outflow since start of simulation	cf
C2CSTT		Total chlorine cost	$/storm
DBOD		Dissolved BOD	lb
DDEPTH		Depth increment of storage reservoirs	ft
DEEP		Depth of air flotation tank	ft
DEPMAX	C	Maximum allowable depth in reservoir	ft
DEPTH	C	Water depth	ft
DEPTHL		Depth for previous time-step	ft
DEPTH2		Depth of storage unit	ft
DESF	C	Design flow fraction of maximum flow	
DETENT	C	Detention time	sec
DETMIN		Detention time	min
DS		Suspended solids removed in the filter	lb/DT
DSTART	C	Reservoir depth at start of pumping	ft
DSTOP	C	Reservoir depth at end of pumping	ft
DSTP		Depth at which pumps start up	ft
DSTRT		Depth at which pumps start up	ft
DS1		Suspended solids stored in the filter	lb/DT
DT	C	Time-step interval	min, sec
DTMORE	C	Additional time-step required to pump wet well down	
DTON	C	Number of time-steps pumping occurred	
DTPUMP	C	Dummy variable	
DT2		Half time-step interval	min
DUM		Increment of arriving flow rate	
DUMDEP	C	Storage depth	ft
DUMSTR	C	Storage capacity	cf
DUMTRM		Routing parameter (= ATERM)	cf
DUMAO2		Term in Routing parameter (= $O_2\Delta t/2$)	cf

TABLE 36. (CONT'D)

Variable Name	C*	Description	Unit
DVR		Parameter indicating unreliable storage unit	
ENR		ENR cost index for year and location	
F		Fraction of chemical dosing flow rate to total flow rate of treatment unit	
FACTOR		Integer for unit conversion	
FAREAB	C	Face area of bar screens	sq ft
FMS		Factor for microstrainer	
FON		Fraction of time-step pumped	
FRAC	C	Fraction of an inflow plug	
FRONT		Computational variable for plug flow	
FR2ST		Fraction of totals entering storage unit	
GPMSF		Flow rate through microstrainer	gpm/ft^2
H		Head over weir	ft
H		Head loss through filter (HIGH)	ft
HCL		Head loss thru filter due to solids load	ft
HEAD1	C	Pump head for inlet lift station	ft
HEAD2	C	Pump head for outlet lift station	ft
HIGHRF		Name of subroutine	
HM	C	Maximum design head loss	
HO		Operation head loss through sand of filters	ft
HRFD	C	Multiplier for number of backwash iterations for high rate filters	
H1		Head over weir	ft
I		Bookkeeping integer	
IA		Bookkeeping integer	
ICHEM	C	Indicator noting if chemicals are added	
ICHEMH	C	Indicator noting if chemicals are added to the high rate filter(s)	
ICL2	C	Indicator for chlorine addition	
ICOST	C	Indicator for cost compilation and summary	
IENR		ENR Index	
INTERP		Name of subroutine	
IPOL	C	Pollution control parameter	
IPRINT	C	Print control parameter	
IRANGE	C	Parameter indicating if quantity ranges are summarized	
ISPRIN	C	Print control parameter	
ISTBUP		Indicator of back up effect	
ISTEXS		Indicator for excess flow handling	
ISTINF		Indicator for nonmodel inflow devices	
ISTMOD	C	Indicator for storage mode	
ISTOR	C	Indicator for separate storage modeling	
ISTOUT	C	Indicator for outlet type	
ISTTYP	C	Indicator for type storage structure	
ITABLE	C	Indicator parameter for summarizing inflows and outflows in table form	
ITR		Indicator of illegal combination of treatment	
ITREAT	C	Treatment parameter	
ITR100		ITREAT x 100	

TABLE 36. (CONT'D)

Variable Name	C*	Description	Unit
J		Title parameter	
JM	C	Same as J	
JM	C	Outfall element numbers transferred by file	
JM5	C	Print control counter	
JP	C	Number of first inlet plugs in outflow	
JS	C	Outfall array pointer designating JMS Element	
J1		Variable indicating if bar racks are used, level 1	
J2		Variable indicating if pumping is used, level 2	
J3		Type of primary treatment, level 3	
J4		Type of secondary treatment, level 4	
J5		Variable indicating if there are effluent screens, level 5	
J6		Variable indicating if there is an effluent pump station, level 6	
J7		Variable indicating if there are chlorine contact tanks, level 7	
K		Bookeeping integer for level of treatment	
KDT	C	Time-step number	
KDTBW		Backwash time-step number	
KENR		Number of years from 1969 to the desired year of the ENR cost index	
KFLAG		Interpolation warning flag	
KHOUR	C	Hour of day during simulation	hr

Variable Name	C*	Description	Unit
KILL		Name of subroutine	
KK		Do loop counter	
KMIN	C	Minute during simulation	min
KMOD	C	Bookkeeping integer for module size	
KNCOMB		Number of illegal treatment combinations	
KNECOM		Parameter indicating inadvisable treatment combinations	
KNTOF	C	Number of times there is storage overflow	
KP		Inlet plug number	
KPASS		Parameter indicating design flow too large	
KRUN		Do loop variable denoting run number	
KYEAR		Calendar year	
L	C	Do loop counter for level of treatment	
LABEL	C	A label number	
LP	C	Number of last inlet plug in outflow	
LPREV	C	LP for previous time-step	
LR		Variable which indicates type and level of treatment	
M		Do loop counter	
MHOUR		Selected hour of simulation when contaminants removals are computed	
MM		Do loop counter	
MMIN		Selected minute of simulation when contaminants removals are computed	
MMM		Do loop counter	

TABLE 36. (CONT'D)

Variable Name	C*	Description	Unit
MODCST	C	Cost of module	$
MODSIZ	C	Treatment module size	mgd
MODYR		Year of desired ENR	
M		Do loop counter	
NAME	C	Name of the treatment option	
ND		Time-step computation variable	
NDT	C	Number of time-steps	
NDTBW		Number of time-steps for backwash	
NEVEN		Number of high rate filter units in even numbers	
NFLAG	C	Indicator of inadmissible treatment combination or time-step length	
NM	C	Time-step when pollution reduction calculations will be made	
NMS	C	Number of microstrainer units	
NN		Counter for plug flow	
NNCOMB		Number of illegal combinations	
NNECON		Number of inadvisable combinations	
NOCOMB		An illegal combination pair	
NOE		Number of elements	
NOESUN		Number of effluent screens	
NOUNIT		Number of treatment module unit	
NOUTS		Number of outfalls from transport Black	
NPOLL	C	Number of pollutants	
NRUNS		Number of different treatment runs	
NSCRN	C	Number of screens	
NSED	C	Number of sedimentation tanks used	
NSTIN		Input file number	
NSTOUT		Output file number	
NUE		Number of the upstream element	
NUNITC		Number of dosing units	
NUNITH	C	Number of high rate filter units	
NYEAR		Dummy variable	
NYRS		Amortization periods	years
OFACT		Fraction of overflow rate to total inflow	
OPRA		Operating flow rate of high rate filter	gpm/sq ft
OPRAMA	C	Maximum operating rate for high rate filter	gpm/sq ft
OTCSTT		Total miscellaneous cost for the storm	$/storm
OTHCST		Storm costs excluding chemical cost	$/storm
OTHSC		Non-chemical storm costs for fine screens	$/storm
OVFRA		Overflow rate	gpd/sq ft
OVRDAF	C	Design overflow rate	gpd/sq ft
OVRSED	C	Design overflow rate of sedimentation tank	gpd/sq ft
PBDOF		Pounds of BOD overflowing out of microstrainer	lb
PBDTR		Pounds of BOD treated by microstrainer	lb
PCL2DM		Chlorine demand rate	lb/day

TABLE 36. (CONT'D)

Variable Name	C*	Description	Unit
PCL2MX		Chlorinator capacity required	lb/day
PLUGS		Name of subroutine	
POLL	C	Pollutants	
PSSOF		Pounds of SS overflowing out of micro-strainer	lb
PSSTR		Pounds of SS treated by microstrainer	lb
PUMPDV		Volume pumped per time-step	cf
Q		Water flowrate	mgd
QAV		Average flow rate of inflow and outflow $(\frac{QQIF + QQRL}{2})$	cfs
QDESYN	C	Design through flow rate for treatment package	cfs
QDSMGD		Design through flow rate for treatment package	mgd
QIN	C	Water inflow rate (hydrograph)	cfs
QINSTL	C	Inflow rate to storage for previous time-step	cfs
QKILL		Disinfectant dosage flow rate	cfs
QMOD	C	Design capacity for treatment module	mgd
QO	C	Outfall flows from TRANS	cfs
QOMAX	C	Maximum outflow from storage unit	cfs
QOUS		Effluent flow rate from screens	cfs
QOUST	C	Outflow rate from storage unit	cfs
QOUSTL	C	Outflow rate for previous time-step	cfs
QOUT		Outflow rate from storage unit	cfs

Variable Name	C*	Description	Unit
QOUTO	C	Initial outflow rate	cfs
QPUMP	C	Constant pump at outflow rate	cfs
QQARR	C	Arrival flow rate	cfs
QQESUN		Module capacity of effluent screens	mgd/unit
QQIF	C	Water arrival rate to model	cfs
QQIFT		Total inflow rate to whole model	cfs
QQIFMN		Minimum inflow rate	cfs
QQIFMX	C	Maximum arrival rate of flow from TRANS	cfs
QQIN	C	Inflow rate of one treatment unit	cfs
QQINMN		Minimum inflow rate for a treatment unit	cfs
QQINMX		Maximum inflow rate for a treatment unit	cfs
QQINT		Total inflow rate to one unit	cfs
QQOF		Overflow rate	cfs
QQOFMN		Minimum overflow rate	cfs
QQOFMX		Maximum overflow rate	cfs
QQOFR		Amount of overflow from storage unit	cfs
QQOFT		Total overflow rate	cfs
QQOU	C	Outflow rate	cfs
QQOUMN	C	Minimum outflow rate	cfs
QQOUMX	C	Maximum outflow rate	cfs
QQOUS		Effluent flow rate from screens	cfs

TABLE 36. (CONT'D)

Variable Name	C*	Description	Unit
QQOUT	C	Accumulative total outflow rate for arithmetic average	cfs
QQRL	C	Effluent from treatment plus bypass flow rate	cfs
QQRLMN		Minimum flow rate from treatment units and bypass line	cfs
QQRLMX		Maximum flow rate released from treatment and bypass line	cf
QQRLT		Accumulative flow rate from treatment units and bypass line	cfs
QQRM	C	Removal flow rate	cfs
QQRMMN	C	Minimum removal flow rate	cfs
QQRMT	C	Accumulative removal flow rate by one treatment step	cfs
QQRS		Flow removed by screens	cfs
QRAT		Ratio of design flow to max. flow from from storage unit	
QU		Capacity of high rate filter per unit	mgd
RATEPC		Interest rate for amortization	%
RIJP		Time-step number	
RIL		Time-step	
RILP		Time-step number	
RECIRC	C	Recirculation flow	%
RKTSTP		Number of time-step (= KDT)	
RL		Number time-steps minus one	
S	C	SS held in high rate filters	lb/sq ft
SBOD	C	BOD in storage unit	lb
SBODC		Average BOD concentration in the storage unit	mg/L
SCIF		SS concentration of the influent	mg/L
SCIFMN		Minimum SS concentration in the influent	mg/L
SCIFMX		Maximum SS concentraton of the influent	mg/L
SCIFT		Accumulative total or arithmetic average of SS concentration of the influent	mg/L
SCIN	C	SS concentration of the inflow to one treatment unit	mg/L
SCINMN		Minimum SS concentration of the inflow	mg/L
SCINMX		Maximum SS concentration of the inflow	mg/L
SCINT		Accumulative total for arithmetic average of SS concentration of the inflow to one treatment level	mg/L
SCOF		SS concentration in the overflow	mg/L
SCOFMN		Minimum SS concentration in the overflow	mg/L
SCOFMX		Maximum SS concentration of overflow	mg/L
SCOFT		Accumulative total for arithmetic average of SS concentration of overflow	mg/L
SCOL	C	Coliform in storage unit	MPN
SCOLC		Coliform concentration in storage unit	MPN/100 ml
SCOU	C	Outflow SS concentration	mg/L
SCOUMN	C	Minimum SS concentration of the outflow	mg/L

TABLE 36. (CONT'D)

Variable Name	C*	Description	Unit
SCOUMX	C	Maximum concentration of SS of outflow	mg/L
SCOUS		SS concentration in the outflow from screens	mg/L
SCOUT	C	Accumulative total for arithmetic average of SS concentration in outflow of one treatment level	mg/L
SCRCAP	C	Capacity per screen	cfs
SCREEN	C	Area of fine screen	sq ft
SCRL		SS concentration of the released flow per time-step	mg/L
SCRLMN		Minimum SS concentration of the released flow	mg/L
SCRLMX		Maximum SS concentration in the released flow	mg/L
SCRLT		Accumulative total for arithmetic average of SS concentration of the released flow	mg/L
SCRM	C	SS concentration of the waste flow from a treatment unit	mg/L
SCRMMN	C	Minimum SS concentration in removal flow	mg/L
SCRMMX	C	Maximum SS concentration removal flow	mg/L
SCRMT	C	Accumulative total for arithmetic average of SS concentration of the removal flow by one treatment level	mg/L
SCRM1		SS removed by microstrainer	mg/L
SEDA	C	Surface area of sedimentation tank	sq ft
SEDEP		Sedimentation tank depth	ft
SEDIM		Name of subroutine	
SEDNUM		Number of sedimentation tanks required	
SITEF		An ENR factor for geographic location of site	
SLOAD		Solids loading on screens	lb/min/sq ft
SOUT		Volume out of plug flow	cf
SPRINT		Name of subroutine	
SQM	C	Maximum solids holding capacity at maximum head and maximum flow rate	lb/sq ft
SREFF		SS removal efficiency	
SREFFH	C	SS removal efficiency of high rate filter	
SREFF1		Same as SREFFH	
SREFF2		Same as SREFFH	
SROUTE		Name of subroutine	
SSARR	C	SS arrival rate	lb/DT
SSCIF		SS concentration of inflow to the whole model (= SSIF)	mg/L
SSCOUT		SS outflow concentration	mg/L
SSCRL		SS concentration of released flow (= SSRL)	
SSIF	C	SS inflow rate (storage)	lb/DT
SSIFRF		Fraction of SS removed to SS flowing into the whole model	
SSIFT		Accumulative total SS in the inflow to the whole model	lb
SSIN	C	SS in flow rate of one treatment level	lb/DT
SSINRF		Fraction of SS removed to SS flowing into each treatment level	
SSINT	C	Accumulative total SS flow into treatment level	lb
SSOF		SS flow rate in overflow	lb/DT

TABLE 36. (CONT'D)

Variable Name	C*	Description	Unit
SSOFT		Accumulative total SS in the outflow from the whole model	lb
SSOU	C	SS outflow rate	lb/DT
SSOUS		SS outflow rate from screens	lb/DT
SSOUT	C	Accumulative total SS outflow from one treatment level	lb
SSRD		SS reduction, percentage	%
SSRL	C	SS released per time-step	lb/DT
SSRLT		Total SS released to the whole model	lb
SSRM	C	SS removed per time-step	lb/DT
SSRMT	C	Accumulative total SS removed from each unit	lb
SSRMTT		Total SS removal from the whole model	lb
SSRS		SS removed by screens	lb/DT
SSRST		Accumulative total SS removed by screens	lb
SSS	C	SS in the storage unit	lb
SSSC		Average SS concentration in the storage unit	mg/L
STMTOT		Total storm costs including chemical and others	$
STOR	C	Water in storage	cf
STORAG		Name of subroutine	cf
STORDV		Buffer volume of storage for pumping	
STORHI		Storage volume at pump starting level	cf
STORL	C	Water in storage at previous time-step	cf
STORLO	C	Storage volume at pump stop level	cf
STORMX	C	Maximum storage capacity	cf
STORZ		Water stored per time-step	cf

Variable Name	C*	Description	Unit
STORO	C	Initial storage	cf
STOT		Total volume of outflow plugs	cf
STRAGE		Name of subroutine	
STRDAT		Name of subroutine	
SUAREA	C	Submerged area	sq ft
SUM		Sum of the inflow volume	cf
SUSIN	C	SS inflow rate (pollutograph)	lb/DT
SUSOUT	C	SS outflow	lb/DT
Si		SS held in high rate filters	lb/sq ft
TCHEM		Total chemical used	lb
TERM		Term in routing equation, $S_2 + O_2\frac{\Delta t}{2}$	cf
TIME		Time of time-step	sec
TIME2M		Time since start of inflow	min
TITLE		Title on input file	
TOTCST	C	Dummy variable	
TRCHEK		Name of subroutine	
TRCOST		Name of subroutine	
TREAT		Name of subroutine	
TRIBA	C	Total area of basin	acres
TRLINK		Name of subroutine	
TRTDAT		Name of subroutine	
TSSOUT		Total output of SS	

TABLE 36. (CONT'D)

Variable Name	C*	Description	Unit
TSURFA	C	Total surface area	sq ft
TZERO		Time of start of storm	sec
UAREAH	C	High rate filter area per unit	sq ft
UCCL2		Unit cost of chlorine	$/lb
UCLAND		Unit cost of land	$/acre
UCLIME		Unit cost of alum	$/lb
UCPOLY		Unit cost of polymers	$/lb
UCPOWR		Unit cost of power	$/KWH
UNESN		Design flow/100	cfs/100
UNESNO		Design flow for effluent screens	cfs
VIKK		Inflow volume per time-step (= VOLIN)	cf
VOKK		Outflow volume per time-step (= VOLOUT)	cf
VOLCON	C	Volume of contact tank	cf
VOLDAF	C	Volume of dissolved air flotation tank	cf
VOLIN	C	Inflow water volume per time-step	cf
VOLOUT	C	Outflow water volume per time-step	cf
VOLOUZ		Water outflow per time-step	cf
VOLSED	C	Volume of sedimentation tank	cf
WAIF		Total water inflow per time-step	cf/DT
WAIFRF		Fraction of water removed to water inflow of the whole model	
WAIFT		Accumulative total inflow volume to the whole model	cf
WAIN	C	Water inflow to one treatment level	cf/DT
WAINRF		Fraction of water removed to water flowing into each treatment level	
WAINT	C	Accumulative total inflow volume to one treatment level	cf
WAOF		Volume of overflow per time-step	cf/DT
WAOFT		Total outflow volume from the whole model	cf
WAOU	C	Water volume from one treatment unit	cf/DT
WAOUT	C	Accumulative total water flowing out one treatment level	cf
WARL		Volume of water released per time-step	cf
WARLT		Total water released	cf
WARM	C	Water removed	cf
WARMT	C	Total water removed by one treatment level	cf
WARS		Water removed by fine screens	cf/DT
WARST		Total water removed by screen	cf
WARMTT	C	Total volume of water removed from the whole model	cf
WEIRHT		Reservoir depth when surface at weir elevation	ft
WEIRL		Weir length	ft
WEIRQ		Outflow through fixed weir by gravity	cfs/ft
Y		Data array number	
YE		Output value	
X		Data array number	
XE		Input value	

TABLE 37. STORAGE SAMPLE INPUT DATA
(Corresponds to Output in
Tables 38 to 43)

```
STORAGE
(1)          1
(2)          1        1.0
(3)    3    14   21   31   42   51   61   72
(4)          2        1         1         1
(6)          4       24.0      2.65
(7)  .085   .37  .043  .32  .03  .13  .021  .18
(8)    1     3    2
(9)          1        1
(10)        25.
(12)       100.       35.       1.
(14)        23.       10.
(16)         0.        0.
(17)        20.
(23)    0    0
(24)       7.0        25       1975       1.0
(25)      1120       1240      1440       1570      1840      1980      2130      2280
(25)      2410       2570      2700
(26)     5000.        .03       .57       1.20       .03
```

TABLE 38. CONTROL INFORMATION PASSED FROM TRANSPORT BLOCK

OUTPUT FROM EXTERNAL STORAGE/TREATMENT MODELS

INPUT DATA-SET OUTFALLS AT THE FOLLOWING ELEMENT NUMBERS:
1

INPUT TO STORAGE/TREATMENT MODEL SUPPLIED FROM EXTERNAL ELEMENT NUMBER 1

NUMBER OF RUNS	=	1
TIME-STEP SIZE	=	5.00 MIN.
NO. TIME-STEPS MODELED	=	80
TRIBUTARY AREA	=	542.20 ACRES
NO. TRANSP. MOD. OUTFALLS	=	1
NO. OF POLLUTANTS	=	3
TIME ZERO	=	16800.0 SEC

TABLE 39. OUTPUT OF SUBROUTINE TRIDT

```
-------  RUN NO. 1  -------

INPUT DATA FOR TREATMENT PACKAGE FOLLOWS


                    CHARACTISTICS OF THE TREATMENT PACKAGE ARE

                        LEVEL      MODE          PROCESS

                          0         03        NO B.R. OR SW.C.
                          1         14        BAR RACKS AND
                                              SWIRL CONCENTRATOR
                          2         21                          (BYPASS)
                          3         31                          (BYPASS)
                          4         42        MICROSTRAINERS
                          5         51                          (BYPASS)
                          6         61                          (BYPASS)
                          7         72        CONTACT TANK

                                                    IPRINT = 2,  ICOST = 1,  IRANGE = 1,  ITABLE = 1

 DESIGN STORM USED.  TREATMENT CAPACITY WILL BE SELECTED TO SUIT.

          DESIGN FLOWRATE =    114.54 CFS.
              (= 1.000 TIMES MAXIMUM ARRIVAL RATE OF     114.54 CFS.)
          TREATMENT SYSTEM INCLUDES MODULE UNITS
               DESIGN FLOW IS THEREFORE INCREASED TO NEXT LARGEST MODULE SIZE
               ADJUSTED DESIGN FLOWRATE =    116.02 CFS., =     75.00 MGD.
               (KMOD =  9)
               CHARACTERISTICS OF STORAGE UNIT ARE
                    OUTLET TYPE   =  2
                    STORAGE MODE =  1
                    STORAGE TYPE =  5

               IPOL = 1, PRINT CONTROL (ISPRIN) = 1

          MAN-MADE RESERVOIR, WITH MAX. DEPTH =  25.00 FT.,  AND CHARACTERISTICS
                    BASE AREA =      100. SQ.FT.,      BASE CIRCUMF. =      35. FT.,      COT(SIDESLOPE) =   1.00000
               RESERVOIR OUTLET CONTROL BY GRAVITY WITH FIXED WEIR
               WEIR HEIGHT = 23.00 FT, WEIR LENGTH =  10.00 FT,  DT =    300.00 SEC. (FROM INPUT HYDROGRAPH)
               DEPTH(FT) STOR(CU.FT)    DEPTH(FT) STOR(CU.FT)    DEPTH(FT) STOR(CU.FT)    DEPTH(FT) STOR(CU.FT)
                  0.0          0.          7.67       1795.         15.33       5648.         23.00      11557.
                 23.29      11817.         23.57      12080.         23.86      12346.         24.14      12615.
                 24.43      12886.         24.71      13160.         25.00      13437.
               THE TWO SETS OF 11 STORAGE PARAMETERS, FOR DT =   300.000 SEC., ARE..
          ATERM..       0.     1795.     5648.    11557.    12580.    14238.    16310.    18717.    21414.    24371.    27565.
          A02DT2..      0.        0.        0.        0.      763.     2157.     3964.     6102.     8528.    11211.    14127.
               ASSUMED UNIT COST (EXCAVATION, LINING, ETC.) =20.00 $/CU.YD.

          PRELIMINARY TREATMENT BY MECHANICALLY CLEANED BAR RACKS  (LEVEL 1)
               NUMBER OF SCREENS    =      2
               FLOW PER SCREEN      =     58.01 CFS
               SUBMERGED AREA       =     19.34 SQ.FT. (PERPENDICULAR TO THE FLOW)
```

TABLE 40. OUTPUT OF SUBROUTINE STRDAT

```
     FACE AREA OF BARS    =      27.07 SQ.FT.

TREATMENT BY SWIRL CONCENTRATOR  (LEVEL 1)
     DIAMETER =  24.0 FT.
     SPGRAV   =  2.65

     4 DIFFERENT PARTICAL SIZES
     NOPART     PSIZE            PCENT
        1       0.085 CM         37.00 %
        2       0.043 CM         32.00 %
        3       0.030 CM         13.00 %
        4       0.021 CM         18.00 %

INFLOW BY GRAVITY (NO PUMPING)  (LEVEL 2)

NO PRIMARY TREATMENT INCLUDED  (LEVEL 3)

TREATMENT BY MICROSTRAINERS
     NUMBER OF UNITS       =          6
     CAPACITY PER UNIT     =      12.50 MGD
     SUBMERGED SCREEN AREA=     217.01 SQ.FT. PER UNIT

NO EFFLUENT SCREENS  (LEVEL 5)

OUTFLOW BY GRAVITY (NO PUMPING)  (LEVEL 6)

TREATMENT BY CHLORINE CONTACT TANK (LEVEL 7)
     NUMBER OF DOSING UNITS =          2
     DOSING RATE PER UNIT   =    8000.00 LB/DAY
     MAXIMUM DEMAND RATE    =   14616.22 LB/DAY
     VOLUME OF CONTACT TANK =   104422. CU.FT, AT 15 MIN. DETENTION TIME
```

TABLE 41. OUTPUT PERFORMANCE PER TIME STEP

TIME HR:MIN	TOTAL INFLOWS FLOW CFS	TOTAL INFLOWS BOD MG/L	TREATMENT OPERATION - INFLOWS FLOW CFS	TREATMENT OPERATION - INFLOWS BOD MG/L	TREATMENT OPERATION - BOD LEVEL-1 MG/L	TREATMENT OPERATION - BOD LEVEL-3 MG/L	TREATMENT OPERATION - BOD LEVEL-4 MG/L	TREATMENT OPERATION - BOD LEVEL-7 MG/L	TREATMENT OPERATION - OUTFLOWS FLOW CFS	TREATMENT OPERATION - OUTFLOWS BOD MG/L	STORAGE OPERATION - INFLOWS FLOW CFS	STORAGE OPERATION - STORAGE BOD MG/L	STORAGE OPERATION - STORAGE STORAGE CF	STORAGE OPERATION - STORAGE DEPTH FT	STORAGE OPERATION - OUTFLOWS FLOW CFS	STORAGE OPERATION - OUTFLOWS BOD MG/L	OVERFLOW - BYPASS FLOW CFS	OVERFLOW - BYPASS BOD MG/L
0 5	2.29	233.58	0.0	0.0 IN	0.0	0.0	0.0	0.0	0.0	0.0	2.3	233.10.34E 03		1.5	0.0	0.0	0.0	0.0
				OUT	0.0	0.0	0.0	0.0										
				REMOVED	0.0	0.0	0.0	0.0										
0 10	2.31	231.18	0.0	0.0 IN	0.0	0.0	0.0	0.0	0.0	0.0	2.3	230.70.10E 04		4.4	0.0	0.0	0.0	0.0
				OUT	0.0	0.0	0.0	0.0										
				REMOVED	0.0	0.0	0.0	0.0										
0 15	2.55	213.36	0.0	0.0 IN	0.0	0.0	0.0	0.0	0.0	0.0	2.6	212.90.18E 04		7.5	0.0	0.0	0.0	0.0
				OUT	0.0	0.0	0.0	0.0										
				REMOVED	0.0	0.0	0.0	0.0										
0 20	6.10	140.19	0.0	0.0 IN	0.0	0.0	0.0	0.0	0.0	0.0	6.1	139.90.31E 04		10.2	0.0	0.0	0.0	0.0
				OUT	0.0	0.0	0.0	0.0										
				REMOVED	0.0	0.0	0.0	0.0										
0 25	23.28	102.37	0.0	0.0 IN	0.0	0.0	0.0	0.0	0.0	0.0	23.3	102.10.75E 04		17.7	0.0	0.0	0.0	0.0
				OUT	0.0	0.0	0.0	0.0										
				REMOVED	0.0	0.0	0.0	0.0										
0 30	60.08	89.88	0.0	0.0 IN	0.0	0.0	0.0	0.0	0.0	0.0	60.1	89.70.13E 05		24.3	0.0	0.0	0.0	0.0
				OUT	0.0	0.0	0.0	0.0										
				REMOVED	0.0	0.0	0.0	0.0										
0 35	96.25	82.73	48.2	97.8 IN	97.82	64.12	64.12	28.23	47.1	28.2	96.3	82.60.13E 05		25.0	48.2	97.8	4.7	82.6
				OUT	64.12	64.12	28.23	28.23										
				REMOVED	2739.14	0.0	2866.48	0.0										
0 40	114.54	75.25	94.2	77.9 IN	77.85	50.99	50.99	36.40	92.1	36.3	114.5	75.10.13E 05		25.0	94.2	77.9	8.9	118.3
				OUT	50.99	50.99	36.40	36.40										
				REMOVED	2182.88	0.0	2314.12	0.0										
0 45	85.78	66.40	94.2	62.7 IN	62.67	41.01	41.01	26.77	92.1	26.7	85.8	66.30.13E 05		25.0	94.2	62.7	1.5	752.2
				OUT	41.01	41.01	26.77	26.77										
				REMOVED	1759.93	0.0	2246.42	0.0										
0 50	77.41	59.78	94.2	56.3 IN	56.28	36.81	36.81	22.92	92.1	22.9	77.4	59.70.13E 05		24.6	94.2	56.3	0.0	0.0
				OUT	36.81	36.81	22.92	22.92										
				REMOVED	1581.87	0.0	2186.19	0.0										
0 55	99.04	59.03	69.8	57.2 IN	57.20	37.42	37.42	17.31	68.3	17.3	99.0	58.90.13E 05		25.0	69.8	57.2	5.0	287.4
				OUT	37.42	37.42	17.31	17.31										
				REMOVED	1607.63	0.0	2328.19	0.0										
1 0	80.36	51.73	94.2	34.5 IN	34.47	22.48	22.48	9.19	92.1	9.2	80.4	51.60.13E 05		24.8	94.2	34.5	0.0	0.0
				OUT	22.48	22.48	9.19	9.19										
				REMOVED	974.32	0.0	2072.77	0.0										
1 5	68.40	44.99	81.4	57.0 IN	56.96	37.26	37.26	19.71	79.6	19.7	68.4	44.90.13E 05		24.6	81.4	57.0	0.0	0.0
				OUT	37.26	37.26	19.71	19.71										
				REMOVED	1600.89	0.0	2374.78	0.0										
1 10	83.78	55.10	94.2	32.5 IN	32.54	32.54	11.77	11.77	67.1	11.8	83.8	41.20.13E 05		24.5	68.6	49.8	0.0	0.0
				OUT	32.54	32.54	11.77	11.77										

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TABLE 42. OUTPUT OF SUMMARY OF TREATMENT EFFECTIVENESS

SUMMARY OF TREATMENT EFFECTIVENESS

TOTALS	FLOW (M.G.)	BOD (LB)	SS (LB)	COLIF (MPN)
INPUT	3.722	2347.7	24745.7	1.13E 18
OVERFLOW (BYPASS)	0.045	1972.6	43022.8	2.95E 17
TREATED	3.539	1475.9	23090.1	4.68E 17
REMOVED	0.079	1080.5	19603.2	4.67E 17
RELEASED	3.460	395.3	3486.8	9.44E 13

REMOVALS	FLOW(M.G.)	BOD (LB)	SS (LB)	
LEVEL 1 (TOTAL)	0.044	521.7	13439.9	= BAR RKS. & SWIRL CON.
LEVEL 3 (TOTAL)	0.0	0.0	0.0	= BYPASS LEVEL 3
LEVEL 4	0.035	558.1	6163.3	= MICROSTRAINERS
LEVEL 5	0.0	0.0	0.0	= NO EFFL. SCREENS
LEVEL 7	0.0	0.8	0.0	= CONTACT TANK
TRASH:				
BAR RACKS	5935.348 CU.FT (AT 50 LB/CU.FT.)			
EFFLUENT SCREENS	0.0 CU.FT (AT 50 LB/CU.FT.).			

REMOVAL PERCENTAGES	FLOW (VOL)	BOD (LB)	SS (LB)	COLIF (MPN)
OF OVERALL INPUTS	2.13	46.03	79.22	41.31
OF TREATED FRACTIONS	2.24	73.21	84.90	99.98

CONSUMPTIONS (LB)	CHLORINE	POLYMERS	
LEVEL 3	0.0	0.0	= BYPASS LEVEL 3
LEVEL 4	0.0	0.0	= MICROSTRAINERS
LEVEL 7	173.3	0.0	= CONTACT TANK
TOTAL	173.3	0.0	

REPRESENTATIVE VARIATION OF TREATMENT PERFORMANCE WITH TIME (OVERALL).

TIME	0: 5	0:40	1:15	1:50	2:25	3: 0	3:35	4:10	4:45	5:20	5:55
WATER											
AV. FLOW (CFS)	0.0	93.13	63.29	37.77	15.98	6.63	4.96	5.76	6.00	5.94	8.42
BOD											
ARRIVING (MG/L)	0.0	77.85	44.13	33.60	32.40	27.77	25.52	26.78	28.46	34.36	52.18
RELEASED (MG/L)	0.0	36.35	9.98	8.11	7.81	6.68	6.14	6.44	1.48	5.64	9.98
% REDUCTION	0.0	54.29	77.85	76.39	76.40	76.43	76.45	76.44	94.92	83.92	81.27
S. SOLIDS											
ARRIVING (MG/L)	0.0	1761.46	912.24	460.62	328.49	206.11	153.34	117.61	106.40	84.56	83.19
RELEASED (MG/L)	0.0	511.24	35.02	35.02	35.02	35.02	34.28	30.69	28.95	24.71	24.41
% REDUCTION	0.0	71.58	96.24	92.56	89.33	83.37	78.11	74.45	73.36	71.39	71.28
COLIFORMS											
ARR (MPN/100ML)	0.0	3.78E 09	1.18E 09	1.56E 09	2.31E 09	2.77E 09	3.06E 09	3.81E 09	4.30E 09	5.85E 09	9.28E 09
REL (MPN/100ML)	0.0	1.08E 06	4.52E 04	1.19E 05	2.49E 05	4.71E 05	6.83E 05	9.93E 05	1.17E 06	1.71E 06	2.72E 06
% REDUCTION	0.0	99.97	100.00	99.99	99.99	99.98	99.98	99.97	99.97	99.97	99.97

SUMMARY OF BYPASS FLOW AND POLLUTANTS

OVERFLOWS OCCURRED DURING 4 TIME STEPS

FLOW (CU.FT)	BOD (LB)	SS (LB)	COLIF (MPN)
4.60E 04	1972.6	43022.8	2.95E 18

TABLE 43. OUTPUT OF SUMMARY OF TREATMENT COSTS

SUMMARY OF TREATMENT COSTS

ASSUMED FUTURE ENGINEERING NEWS RECORD INDICES
CONSTRUCTION - 20 CITY AVERAGE

YEAR	ENR INDEX
1970	1120
1971	1240
1972	1440
1973	1570
1974	1840
1975	1980
1976	2130
1977	2280
1978	2410
1979	2570
1980	2700

COST PARAMETERS . .

INTEREST RATE	=	7.00 PERCENT
AMORTIZATION PERIOD	=	25 YEARS
CAP. RECOVERY FACTOR	=	0.0858
YEAR OF SIMULATION	=	1975
SITE LOCATION FACTOR	=	1.0000

UNIT COSTS . .

LAND	=	5000.00 $/ACRE
POWER	=	0.030 $/KWH
CHLORINE	=	0.370 $/LB
POLYMERS	=	1.200 $/LB
ALUM	=	0.03 $/LB

		CAPITAL COSTS		ANNUAL COSTS			STORM EVENT COSTS		
TREATMENT	LEVEL	INSTAL	LAND	INSTAL	LAND	MIN MAINT	CHLORINE	CHEM	OTHER
BAR RACK & SW.C.	1	625808.	619.	47015.	43.	5479.	0.	0.	3311.
NO INLET PUMPING	2	0.	0.	0.	0.	0.	0.	0.	0.
BYPASS LEVEL 3	3	0.	0.	0.	0.	0.	0.	0.	0.
MICROSTRAINERS	4	706869.	0.	60657.	0.	14137.	0.	0.	36.
NO EFFL. SCREENS	5	0.	0.	0.	0.	0.	0.	0.	0.
NO OUTLET PUMPS	6	0.	0.	0.	0.	0.	0.	0.	0.
CONTACT TANK	7	364981.	2437.	31319.	171.	7300.	64.	0.	15.
	SUBTOTAL	$ 1697657.	$ 3055.	$ 138991.	$ 214.	$ 26916.	$ 64.	$ 0.	$ 3362.
	TOTAL	$ 1700712.		$ 166121.			$ 3426.		
	TOTAL PER TRIB ACRE	$ 3137.		$ 306.			$ 6.		

Bedford Treatment [illegible] 0.35 MGD.

7. RECEIVING WATER BLOCK

7.1 Introduction

The RECEIVING WATER Block simulates the behaviour of estuaries, reservoirs, lakes, and rivers. The program has two parts which may be used together or separately. In Part A, the time history of stage, velocity, and flow is generated for various points in the system. In Part B, the computed hydrodynamics are utilized to model the behaviour of conservative and non-conservative quality constituents.

The receiving water is simulated by discretizing the continuous system into a series of one and two-dimensional link and node elements. One-dimensional elements are used to represent rivers and specific channels, and two-dimensional elements to represent areas of continuous water surface. For each time step, the equations of motion and continuity are applied to all nodal points to derive the hydrodynamics for the system. Then the hydrodynamics can be used with equations for conservation of mass to determine the concentration of quality constituents.

The relationships among the subroutines which comprise the RECEIVING WATER Block are shown in Figure 22. The Canadian version of this Block is identical the to EPA SWMM Version II. Complete coding information is included in this section, and is shown in Tables 44 and 45 and on Figure 23.

7.2 Example Application

A hypothetical example of an application of the RECEIVING WATER Block for the simulation of dissolved oxygen, using a simplified river system, is presented in this section. For this example, a steady flow of 350 cfs was assumed in the river with an average velocity of 0.05 fps. Figure 24 shows the layout of nine junctions and eight channels (each one mile long and 440 feet wide) used in the simulation. Three identical combined sewer overflow discharges to nodes 1, 2 and 3 occur during the first six hours of Day 2.

Table 46 shows the input data used in this simulation. The numbers to the left of each line of data represent card group numbers used in Table 44 to describe the data formats.

Table 47 is a printout of the input data which is useful for reference or verification purposes.

Table 48 shows the quantity output from the simulation. Printout results are shown for six junctions and six channels, as shown on the output sheets.

Figure 25 shows a plot of the stage at junction 1 versus time, corresponding to the results shown on Table 48.

Table 49 shows the input data for the quality simulation, including both control data and initial quality constituent concentrations.

Table 50 shows the resulting quality simulation output. Dissolved oxygen profiles along the river system, plotted from the simulation results, are shown on Figure 24.

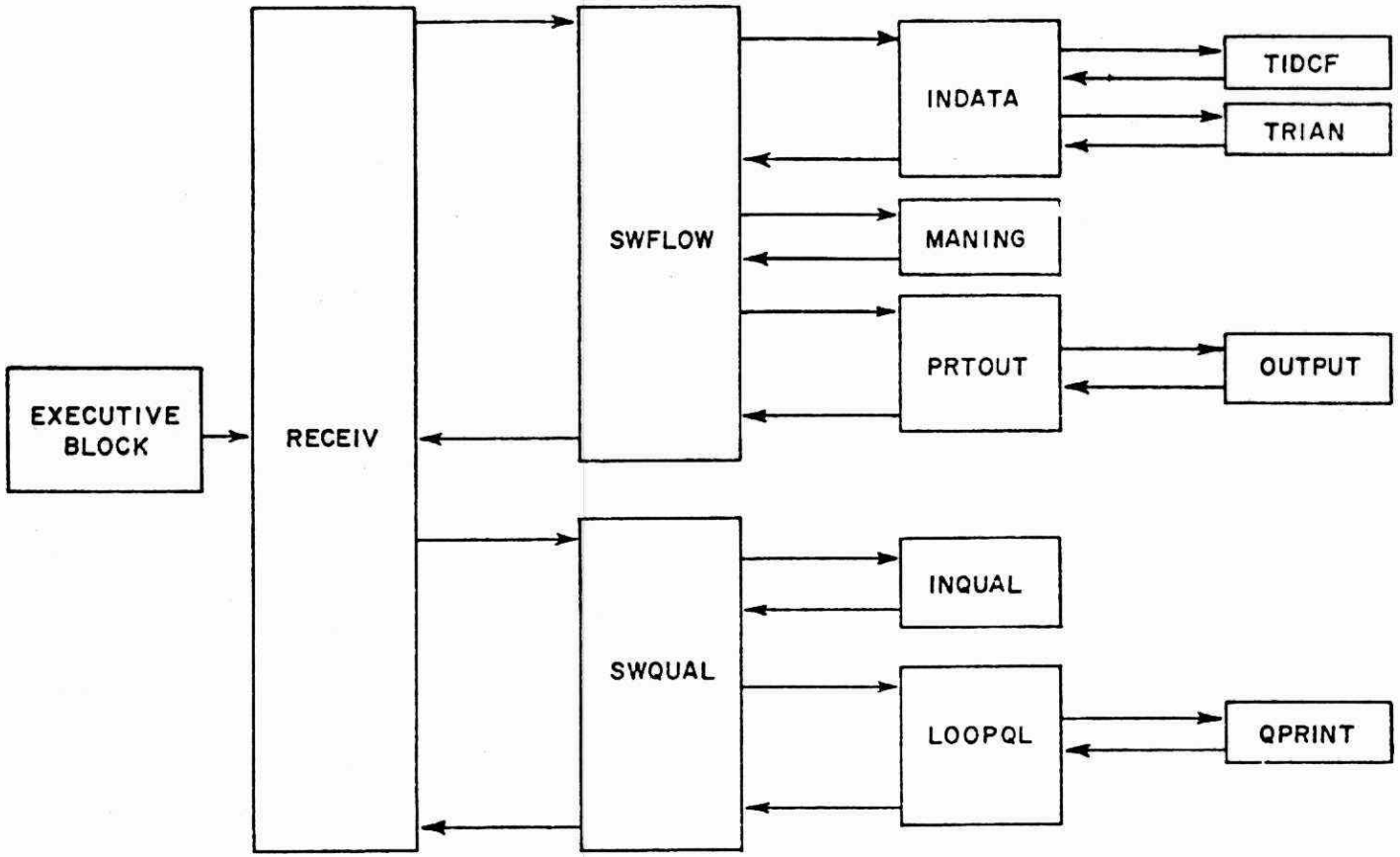


FIGURE 22. PROGRAMS OF THE RECEIVING WATER BLOCK

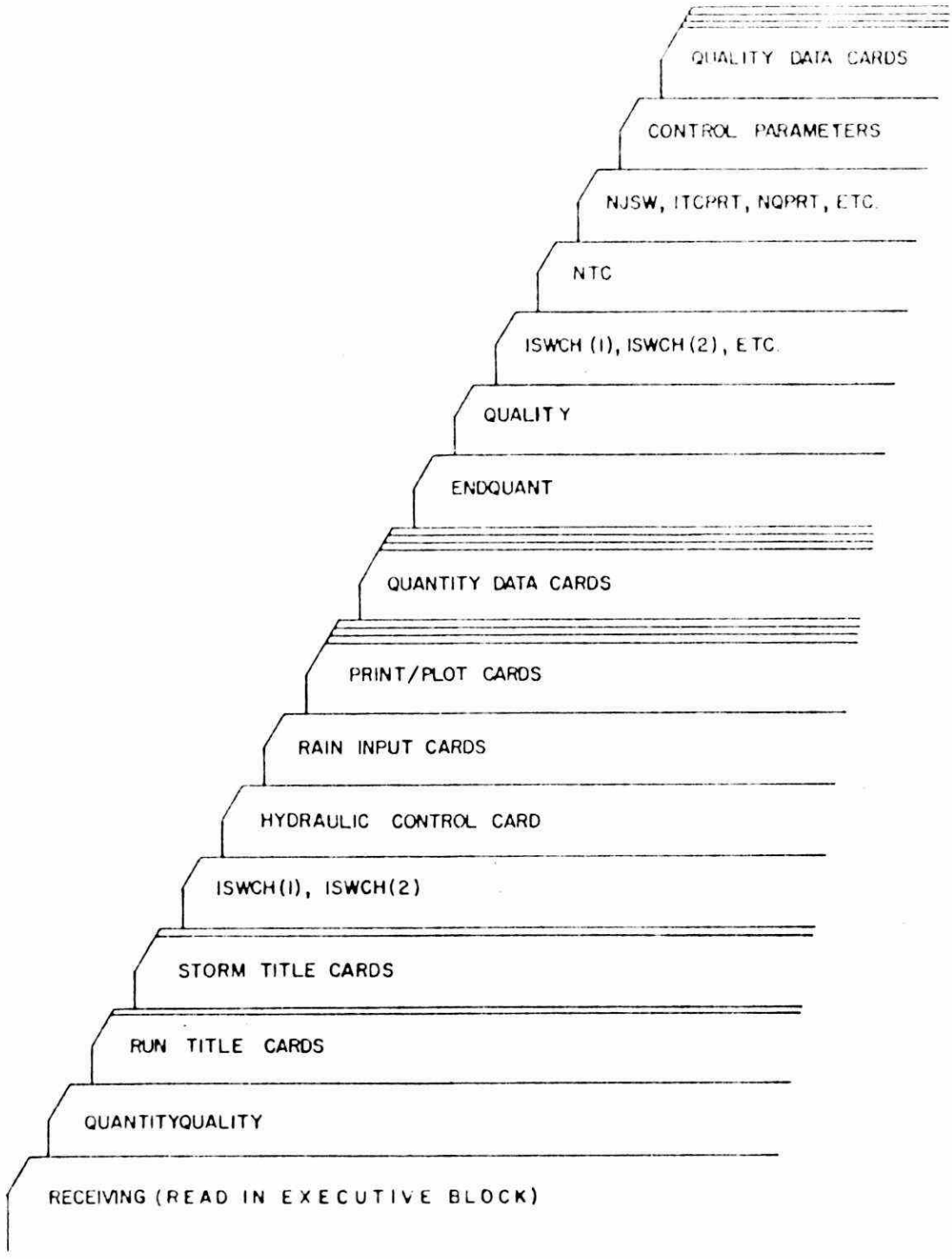
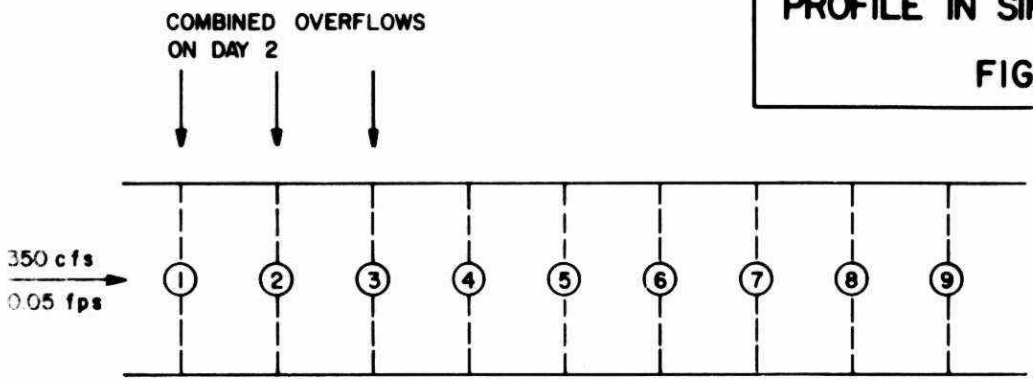
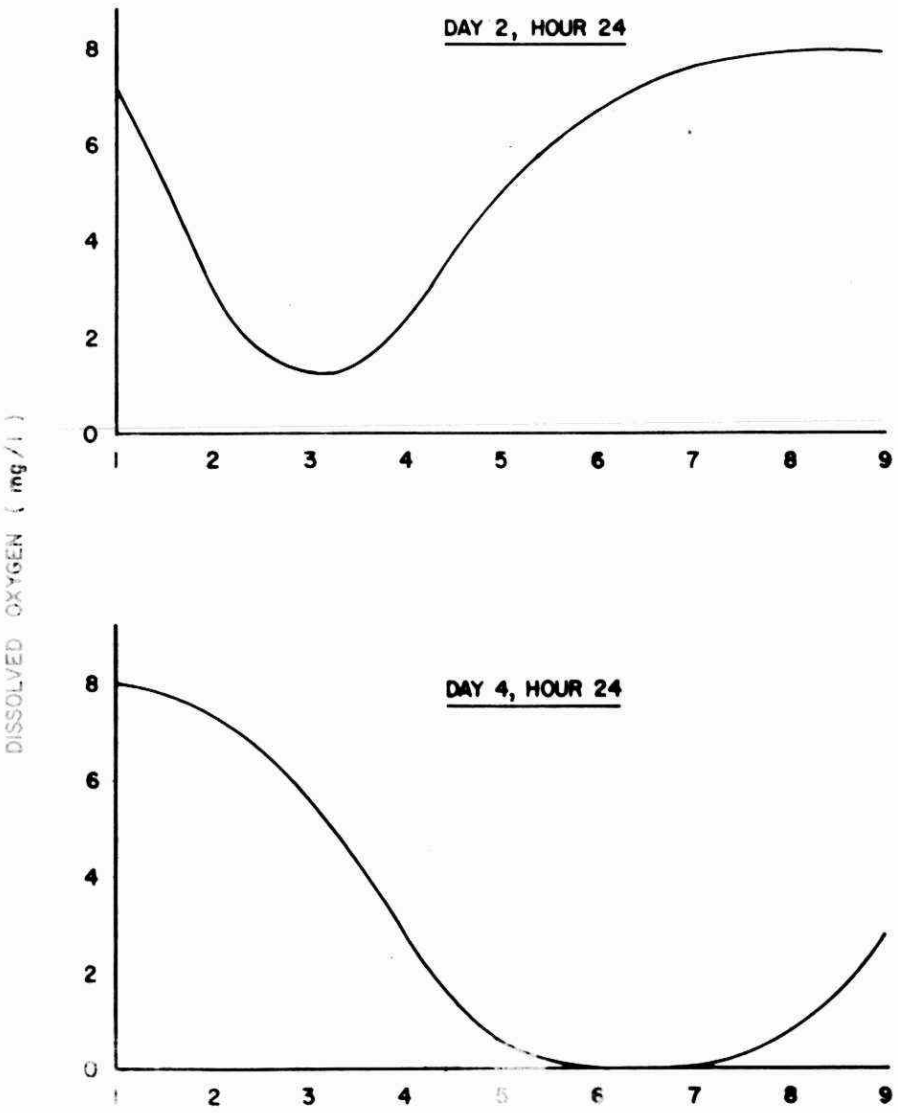


FIGURE 23. DATA DECK FOR RECEIVING WATER BLOCK

SWMM SIMULATION OF
DISSOLVED OXYGEN
PROFILE IN SIMPLIFIED RIVER

FIG. 24





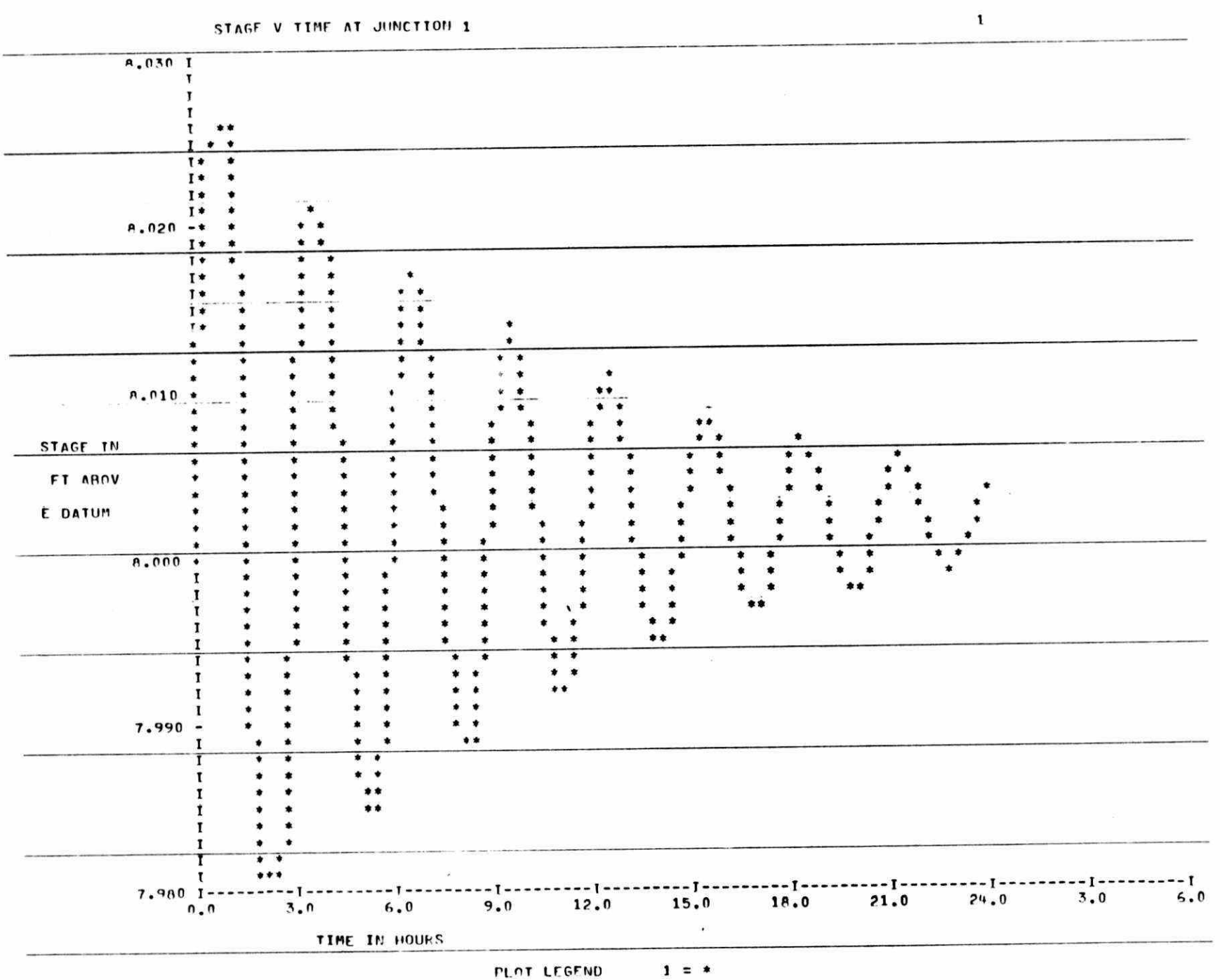


FIGURE 25. QUANTITY OUTPUT STAGE VERSUS TIME AT JUNCTION 1

TABLE 44. RECEIVING WATER BLOCK CARD DATA

Card group	Format	Card columns	Description	Variable name	Default value
1			Control Card.[a]		
	4A4	1-8	If hydraulic calculations are to be carried out, write QUANTITY.		Blanks
		9-16	If quality modeling is to be accomplished, write QUALITY.		Blanks
			IF QUANTITY ANALYSIS IS NOT SELECTED, SKIP TO CARD GROUP 31.		
			QUANTITY MODEL DATA.		
2			Run title card, 2 cards.		
	15A4	1-60	Two card title for run.	ALPHA	Blanks
3			Storm title card, 2 cards.		
	15A4	1-60	Two card title for storm.	TITLE	Blanks
4			Control switches.		
	10I5	1-5	= 0, System is influenced by downstream head relationship (dam),	ISWCH(1)	0
			= 1, System is tidally influenced,[b]		
			= 2, System has specified outflow, as read in card groups 26 or 28.		
			= 3, System has multiple boundary-condition junctions. Type is specified in card group 10.		
		6-10	= 0, Print input channel and junction data,	ISWCH(2)	0
			= 1, Skip printing of input channel and junction data.		
		11-15	= 1, Spatially variable rainfall allowed. Junction inflows computed using card groups 23 to 27.	ISWCH(3)	0

[a] If both QUANTITY and QUALITY are punched, the program first carries out quantity, then quality analysis.

[b] A "tidal" boundary condition can include specification of a constant head (e.g. entering a lake).

TABLE 44. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
		16-20	= 1, Triangles are used in card group 17 and specified roughness values are desired for each leg of the triangle.	ISWCH(4)	0
		21-25	= 1, Parallel channels are used between same two junctions to model different hydraulic characteristics.	ISWCH(5)	0
		26-30	= 0, Junction surface area must be left out of input data card group 15 when triangles are used in card group 17,	ISWCH(6)	0
			= 1, Junction surface area must be furnished to card group 15 when triangles are used in card group 17.		
		31-35	= 1, Manning's coefficients for channels are computed at each time step on basis of empirical relationship of n *vs* depth.	ISWCH(7)	0
		36-40	Not used.	ISWCH(8)	0
		41-45	Not used.	ISWCH(9)	0
		46-50	Not used.	ISWCH(10)	0
5			Hydraulic control card.		
	15	1-5	Number of day cycles desired.	NTCYC	None
	4F5.0	6-10	Number of hr/day cycle. This is also the period (or multiple of the period) of the tidal cycle.	PERIOD	None
		11-15	Length of quality time-step, hr. (Maximum of 30 quality time-steps per day cycle).	QINT	None
		16-20	Length of hydraulic time-step, sec.	DELT	None
		21-25	Initial time for start of hydrograph input from cards, hr.*	TZERO	None

* TZERO = 0 following 1 day of printed output

TABLE 44. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
	3I5	26-30	Number of junctions for time-history printout.	NHPRT	None
		31-35	Number of channels for time-history printout.	NQPRT	None
		36-40	Number of plots desired.*	NPLT	0
	3F5.0	41-45	Evaporation, in/mo.	EVAP	0
		46-50	Wind velocity, mph.	WIND	0
		51-55	Wind direction, clockwise, degrees from North.	WDIR	0
	5I5	56-60	Day cycle where printed output will start.**	NQSWRT	None
		61-65	Number of junctions of stormwater input from cards.	NJSW	0
		66-70	Number of input times of rain information.	INRAIN	0
		71-75	Junction number where a head relationship is specified. JGW can be zero if ISWCH(1) = 2. If ISWCH(1) = 3, NJGW = total number of boundary condition junctions (maximum = 20). Actual junction numbers are read in card group 10.	JGW or NJGW	None
		76-80	If ISWCH(5) = 1 on card 4, then channel numbers greater than this number (NCGT) are parallel to other lower numbered channels. If ISWCH(7) = 1 on card 4, Manning's coefficients for channel numbers greater than NCGT are not calculated at each time-step but are constant as read in.	NCGT	0
			IF INRAIN = 0 ON CARD 5, SKIP RAIN INPUT CARD 6.		
6			Rain input cards, INRAIN pairs of values, 8 per card (Maximum number pairs = 100).		
	8F10.0	1-10	Rate of precipitation, in/hr.	RAIN(1)	None
		11-20	Time from start of storm, min.	INTIME(1)	None

* NPLT ≠ 1

** TZERO occurs following 1 day cycle of printed output

TABLE 44. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
		21-30 31-40	Etc., up to INRAIN points.	RAIN(2) INTIME(2)	None
7			Junctions selected for stage-history printout, NHPRT (card 5) values, 8 per card (maximum = 50).		
	8I10	1-10	First junction number.	JPRT(1)	None
		11-20	Second junction number.	JPRT(2)	None
		.	.	.	
		.	.	.	
		.	.	.	
		.	.	.	
		.	Last junction number	JPRT(NHPRT)	None
8			Channels selected for flow print, NQPRT (card 5) values, 8 per card (maximum = 50).		
	8I10	1-7	Lower junction n. (numerically lower) at end of first desired channel.[a]	CPRT(1)	None
		8-10	Higher junction no. (numerically higher) at end of first desired channel.[a]		
		11-17	.	CPRT(2)	None
		18-20	.	.	
		.	.	.	
		.	.	.	
		.	.	.	
		.	Lower junction no. (numerically lower) at end of last desired channel.	.	
		.	.	.	
		.	.	CPRT(NQPRT)	None
		.	Higher junction no. (numerically higher) at end of last desired channel.		
		.			

[a]Right adjust all numbers.

TABLE 44. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
			IF NPLT = 0 ON CARD 5, SKIP CARD GROUP 9.		
9			Junctions selected for head plot, NPLT (card 5) values (maximum = 50).		
	8I10	1-10	First junction to be plotted.	JPLT(1)	None
		11-20	Second junction to be plotted.	JPLT(2)	None
		.	.	.	
		.	.	.	
		.	.	.	
		.	Last junction to be plotted.	JPLT(NPLT)	None
			IF ISWCH(1) ≠ 3 ON CARD 4, SKIP DIRECTLY TO CARD 11 OR 13. IF ISWCH(1) = 3, REPEAT CARD GROUPS 10 AND 11/12 OR 13 NJGW (CARD 5) NUMBER OF TIMES (Maximum = 20).		
10			Multiple boundary condition card.		
	2I5	1-5	Junction number of boundary condition junction.	JGW	None
		6-10	Type of boundary condition.	IIBC	1
			= 1, Tidal (include card groups 11, 12),		
			= 2, Weir (include card 13)		
			IF ISWCH(1) = 2 ON CARD 4, SKIP TO CARD 14. IF ISWCH(1) = 0, SKIP TO CARD 13. INCLUDE CARDS 11, 12 IF ISWCH(1) = 1 OR IF IIBC = 1 ON CARD 10.		
11			Tide input control card.		
	4I5	1-5	If = 1 will expand from only four tidal stages (HHW, LLW, LHW, HLW over one daily cycle of length = PERIOD) for tidal coefficients.	KO	0
		6-10	Number of tidal stage data points, maximum = 50. (NOTE: Set NI = 4 if KO = 1).	NI	None

TABLE 44. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
		11-15	Maximum number of iterations for curve fit, usually 50.	MAXIT	50
		16-20	= 0, Skip tidal I/O print,	NCHTID	0
			= 1, Print all parameters used.		
12			Tidal stage card, NI pairs of values, 4 pairs/card.[a] NOTE: If KO = 1 only four stages (HHW, LLW, LHW, HLW) are read, in appropriate time sequence.		
	8F10.0	1-10	Time in hours of tidal stage, first point.[b]	TT(1)	None
		11-20	Tidal stage (ft), first point.[c]	YY(1)	None
		21-30	Time in hours of tidal stage, second point.	TT(2)	None
		31-40	Tidal stage (ft), second point.	YY(2)	None
		.	.	.	
		.	.	.	
		.	.	.	
		.	Tidal stage (ft), last point.	YY(NI)	None
			SKIP TO CARD 14 IF ISWCH(1) ≠ 0 ON CARD 4 OR IIBC ≠ 2 ON CARD 10.		
13			Downstream head stage card.		
	3F10.0	1-10	WEIR factor.	WEIR1=A1	None
		11-20	Elevation of top of WEIR, ft (referenced to datum plane).[d]	WEIR2=A2	None
		21-30	Power law for WEIR.	WEIR3=A3	None

[a] Tidal stage is for the first day of simulation.

[b] Time range TT(1) to TT(NI) may exceed PERIOD of card 5.

[c] Tidal stage is for the first day of simulation. This will be repeated on subsequent days.

[d] Datum plane usually mean low low water.

TABLE 44. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
			SKIP TO CARD 15 IF ISWCH(7) ≠ 1 ON CARD 4.		
14			Variable Manning's roughness card. Four pairs of depth *vs* n values are required.		
	8F10.0	1-10	Lowest depth, ft (should be zero).	DNN(1)	0
		11-20	Manning's n corresponding to lowest depth.	VARN(1)	None
		21-30	Next depth, ft.	DNN(2)	0
		31-40	Corresponding Manning's n.	VARN(2)	None
		41-50	Next depth, ft.	DNN(3)	0
		51-60	Corresponding Manning's n.	VARN(3)	None
		61-70	Highest depth, ft.	DNN(4)	0
		71-80	Corresponding Manning's n.	VARN(4)	None
			REPEAT CARD 15 FOR EACH JUNCTION (maximum = 100).		
15			Junction cards.		
	I5	1-5	Junction number.	J	None
	F5.0	6-10	Water surface-elevation, ft [a] (referenced to datum plane).	HEAD(J)[b]	None
		******	IF ITEMP(3) ON CARD 17 IS SUPPLIED *LEAVE SURFACE AREA BLANK* UNLESS ISWCH(6) = 1 ON CARD 4.[c] ******		
	F10.0	11-20	Surface area of junction, millions of sq ft.[d]	AS(J)=SURF	None

[a] Datum plane usually mean low low water. (Approximate elevations are usually sufficient).

[b] Head is negative when below datum plane.

[c] However, if the junction area is to be added to junction area computed for triangle, include surface area and set ISWCH(6) = 0. See discussion of Figure 8-3.

[d] Half of the surface area of the previous channel plus half of the surface area of succeeding channel.

TABLE 44. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
	2F5.0	21-25	Constant junction flow into receiving waters, cfs.	QIN(J)=QF1	None
		26-30	Constant junction flow out of receiving waters, cfs.	QOU(J)=QF2	None
	2F10.0	31-40	Junction depth, ft.[a]	DEP(J)=DT	None
		41-50	Junction Manning's coefficient. (Include Manning's coefficient if program develops geometric data. Channel roughness will be average of two end junctions unless ISWCH(4) = 1 on card 4.)	COF(J)=CF	None
	20X	51-70	Leave columns blank.		
		******	X AND Y COORDINATES REQUIRED ONLY IF WIND ≠ 0 ON CARD 5 OR NTEMP(3) ≠ 0 ****** ON CARD GROUP 17.		
	2F5.0	71-75	X-coordinate (easterly), thousands of ft.	X(J)=X1	None
		76-80	Y-coordinate (northerly), thousands of ft.	Y(J)=Y1	None
16	I5	1-5	To terminate junction cards, write 99999.		None
			REPEAT CARD 17 FOR EACH CHANNEL OR TRIANGLE (maximum number of channels = 225).		
17			Channel or triangle cards.		
	5I5	1-5	Channel or triangle number.[b]	N	None
		6-10	Junction at lower end of channel (numerically lower).	NTEMP(1)	None
		11-15	Junction at upper end of channel (numerically higher).	NTEMP(2)	None
		16-20	Blank unless program is used to develop geometric data through the use of triangles. Then NTEMP(1), NTEMP(2), NTEMP(3) are the vertices of an *acute triangle*. Program will develop channel characteristics.	NTEMP(3)	0

[a] Depth is distance to bottom from datum plane (downward is positive).

[b] These numbers may be changed by program.

TABLE 44. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
		21-25	Blank unless it is the number of a fourth junction which lies midway between NTEMP(1) and NTEMP(3). Program will develop geometric data.	NTEMP(4)	0
		******	IF NTEMP(3) IS SUPPLIED THEN LEAVE COLUMNS 26-75 BLANK. *BUT* IF ISWCH(4) = 1 ON CARD 4, ALEN = MANNING'S ROUGHNESS FOR CHANNEL NTEMP(1) TO NTEMP(2), WIDTH = MANNING'S ROUGHNESS FOR CHANNEL NTEMP(2) TO NTEMP(3), RAD = MANNING'S ROUGHNESS FOR CHANNEL NTEMP(1) TO NTEMP(3). ******		
	5F10.0	26-35	Length of channel, ft.	ALEN	None
		36-45	Average width of channel, ft.	WIDTH	None
		46-55	Average depth of channel, ft.[a]	RAD	None
		56-65	Manning's coefficient, n.	COEF	0.018
		66-75	Initial velocity, ft/sec.	VEL	0
18	I5	1-5	To terminate channel cards, write 99999.		None
			IF NPLT = 0 ON CARD 5, SKIP TO CARD 22.		
19			Plot title card.		
	18A4	1-72	Title for plot output.	TITL	None
20			Plot horizontal label card.		
	20A4	1-80	Label below the x axis.	HORIZ	None

[a]Depth is distance to bottom from datum plane (downward is positive).

TABLE 44. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
21			Plot vertical label card.		
	6A4	1-8	Line 1 of the vertical label.	VERT(1) VERT(2)	None
		9-16	Line 2 of the vertical label.	VERT(3) VERT(4)	None
		17-24	Line 3 of the vertical label.	VERT(5) VERT(6)	None
			IF NJSW = 0 ON CARD 5, SKIP TO CARD GROUP 30.[a]		
22			Stormwater input control card, NJSW (card 5) values (maximum = 50).		
	16I5	1-5	Number of first junction receiving stormwater input.	JSW(1)	None
		6-10	Number of second junction receiving stormwater input.	JSW(2)	None
		.	.	.	
		.	.	.	
		.	.	.	
		.	Number of last junction receiving stormwater input.	JSW(NJSW)	None
			IF ISWCH(3) ≠ 1 ON CARD 4, SKIP TO CARD GROUP 28; OTHERWISE INCLUDE CARDS 23 THROUGH 27.		
23	3I5	1-5	Total number of time inputs of rainfall and stormwater flows (maximum = 100).	NTIMST	None
		6-10	Total number of rain gages (maximum = 50).	NGAGE	None

[a]NOTE: If stormwater input is provided to the same junction(s) from both tape/disk and cards, the card input will override the tape/disk input.

TABLE 44. (CONT'D)

Card group	Format	columns	Description	Variable name	Default value
		11-15	Units for time inputs (card group 24): 0 = seconds 2 = hours 1 = minutes 3 = days	NTCC	0
			INPUT TIMES FOR RAINFALL INTENSITIES AND STORMWATER HYDROGRAPHS. UNITS CORRESPOND TO THOSE GIVEN ON CARD 23.		
24	8F10.0	1-10	Time of first inflow (time of day).[a]	TEEM(1)	None
		11-20	Time of second inflow.	TEEM(2)	None
		.	.	.	
		.	.	.	
		.	.	.	
		.	Time of last inflow (should be larger than expected time of analysis).	TEEM(NTIMST)	None
			REPEAT CARD 25 FOR EACH JUNCTION LISTED IN CARD GROUP 20 (maximum = 50).		
25	16F5.0	1-5	Fraction of rainfall from first gage allocated to junction.	RCENT (NJSW,NGAGE)	None
		6-10	.	.	
			.	.	
		11-15	.	.	
		.	.	.	
		.	Fraction of rainfall from last gage allocated to junction.		
			REPEAT CARD 26 FOR EACH INPUT TIME.		
26			Stormwater hydrograph input cards.[b]		

[a] This is cumulative time if more than one day is simulated.

[b] NOTE: Variable outflows may be read as negative inflow values.

TABLE 44. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
	8F10.0	1-10	Flow volume for first junction, cfs.	EXXT (NTIMST,NJSW)	None
		11-20	.		
		.	.		
		.	.		
		.	Flow volume for last junction, cfs.		
			REPEAT CARD 27 FOR EACH INPUT TIME.		
27	16F5.0	1-5	Rainfall intensity for first rain gage, in/hr.	DRAIN(1)	None
		6-10	.	.	
			.	.	
		11-15	.	.	
		.	.	.	
		.	.	.	
		.	Rainfall intensity for last rain gage, in/hr.	DRAIN(NGAGE)	None
			IF ISWCH(3) = 1 ON CARD 4, SKIP TO CARD 30. REPEAT CARD 28 FOR EACH INPUT TIME (maximum = 50 junctions).		
28			Input hydrograph.[a]		
	8F10.0	1-10	Time of day, sec.[b]	TE(1)	None
		11-20	Flow volume for first junction, cfs.	QE(1,1)	None
		21-30	Flow volume for second junction, cfs.	QE(1,2)	None
		.	.	.	
		.	.	.	
		.	.	.	
		.	Flow volume for last junction, cfs.	QE(1, NJSW)	None
29	F10.0	1-10	Terminate input hydrograph cards with * TE(1) beyond expected time of analysis.		None

[a] NOTE: Variable outflows may be read as negative inflow values.

[b] This is cumulative time if more than one day is simulated.

* It is necessary to specify a time (TE) and zero flow rate (QE) to complete each hydrograph to avoid interpolation of final value to this time.

TABLE 44. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
30			Final data card.		
	2A4	1-8	Write ENDQUANT.		None
			END OF QUANTITY DATA CARDS.		
			QUALITY MODEL DATA.		
31			Control switches (1 is yes, 0 is no).		
	10I5	1-5	Restart from scratch file 3.	ISWCH(1)	0
		6-10	Skip printing of maximum and minimum concentrations.	ISWCH(2)	0
		11-15	Write restart data on scratch file 4.	ISWCH(3)	0
		16-20	Is a non-conservative pollutant to be modelled.	ISWCH(4)	0
		21-25	Tidally influenced receiving water.	ISWCH(5)	0
		26-30	Input from cards (or tape/disk) on first day of quality simulations.[a]	ISWCH(6)	0
		31-35	Variable oxygen saturation coefficients.	ISWCH(7)	0
			= 0, Same constant value at all junctions,		
			= 1, Different constant value at each junction,		
			= 2, Computed at each time step as function of temperature and chloride concentration. (NOTE: Chlorides must be one of the constituents when this option is used.)		
		36-40	Variable reaeration coefficients.	ISWCH(8)	0
			= 0, Same constant value at all junctions.		
			= 1, Different constant value at each junction.		

[a] TZERO occurs on first day of input from cards or tape/disk.

TABLE 44. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
			= 2, Computed at each time step as function of depth and velocity using O'Connor-Dobbins formula.		
		41-45	Not used.	ISWCH(9)	0
		46-50	Use only the daily quantity cycle on input file indicated by value of ISWCH(10). Value of zero indicates use of all days.	ISWCH(10)	0
			IF ISWCH(1) = 0 ON CARD 31, SKIP TO CARD 33. RESTARTING FROM SCRATCH FILE 3.		
32			Daily cycle card.		
	I5	1-5	Number of daily cycles desired.[a]	NTC	None
			THIS WOULD BE LAST CARD OF DATA DECK IF ISWCH(1) = 1 ON CARD 31, EXCEPT FOR CARD GROUP 39.		
33			Storm water and print card.		
	10I5	1-5	Number of junctions with stormwater input from cards (maximum = 20).[b]	NJSW	None
		6-10	Initial daily cycle at which detailed quality information will print.	ITCPRT	None
		11-15	Number of quality time steps between printing out of quality results.[c]	NQPRT	None
		16-20	Total number of quality cycles printed (maximum = 50).	LQCPRT	None
34			Control parameters.		
	3I5	1-5	Number of daily cycles desired.	NTC	None

[a]This is the total number of cycles, including those used previously in generating the restart tape.

[b]NOTE: If stormwater input is provided to the same junction(s) from both tape/disk and cards, the card input will override the tape/disk input.

[c]Quality time step is read on card 5.

TABLE 44. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
		6-10	Number of constituents (maximum total number = 6).[a]	KCON	None
		11-15	Print interval, days.	NPRT	None
	2F5.0	16-20	Ocean exchange ratio at tidal point (JGW). This is fraction of inflowing flood tide that consists of returning outflow from prior ebb tide (*e.g.*, if XRQD = 0.20, 80% of inflow or flood tide consists of fresh ocean water).	XRQD[b]	0
		21-25	Water temperature, °C (range $0 \leq$ TEMP ≤ 30). Required only if ISWCH(7) or ISWCH(8) = 2.	TEMP	0
	2I5	26-30	Constituent number corresponding to chlorides. Determined from sequence of 35, 36 cards. Required only if ISWCH(7) = 2.	ICL	0
		31-35	Constituent number corresponding to coliforms. Determined from sequence of 35, 36 cards. KOLIF = 0 means coliforms are not simulated.	KOLIF	0
			FOR EACH QUALITY CONSTITUENT READ A SET OF 35 AND 36 CARDS.		
35			Quality boundary and decay data.		
	I5	1-5	Head-stage control node.[b]	JGW	None
	F10.0	6-15	Boundary concentration at JGW (*e.g.*, in ocean water) of constituent, mg/ℓ (or MPN/100 mℓ for coliforms).	CS	0

[a]NOTE: If BOD is modeled, DO will be added automatically as the extra constituent (number KCON+1) and should not be included in KCON.

[b]If multiple boundary junctions are used, JGW is not required, and the program automatically assigns parameters XRQD, CS and CSAT to all tidal boundary junctions.

TABLE 44. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
	3E5.0	16-20	Boundary dissolved oxygen at JGW (*e.g.*, in ocean water) and constant saturation value for receiving water if ISWCH(7) = 0, mg/ℓ.	CSAT	0
		21-25	Reaeration coefficient, day^{-1}.*	REAER	0
		26-30	First order decay exponent for non-conservative constituent, day^{-1}.[a]	DECAY	0
	5X	31-35	Leave columns blank.		
	6A4	36-59	Constituent name.	TITLE	Blanks
			FOR EACH NODE WITH A NON-ZERO INITIAL VALUE, INCLUDE CARD 36.		
36			Junction quality data.		
	I5	1-5	Node number.	JTT	None
	7F10.0	6-15	Initial concentration of node, mg/ℓ (or MPN/100 mℓ for coliforms).	CTT	0
		16-25	Constant mass loading, lbs/day (or MPN/min for coliforms).	CPP	0
		******	THE FOLLOWING FOUR VALUES REQUIRED ONLY ON CARDS FOR NON CONSERVATIVE CONSTITUENTS ******		
		26-35	Initial nodal dissolved oxygen concentration, mg/ℓ. **	CTTOX	0
		36-45	Dissolved oxygen concentration of inflow, mg/ℓ.	CPPOX	0
		******	THE FOLLOWING VALUE REQUIRED FOR BOD IF ISWCH(7) = 1 ON CARD 31. ******		

[a]NOTE: With present programming, any non-conservative constituent (DECAY > 0) will be treated similarly to BOD-DO, that is, an extra constituent analagous to DO will be added and simulated. It will not affect simulation of the non-conservative constituent, but must be remembered in total number of constituents.

* Set this equal to DECAY when modelling coliforms.
** Set this equal to a large number when modelling coliforms.

TABLE 44. (CONT'D)

Card group	Format	Card columns	Description	Variable name	Default value
		46-55	DO saturation concentration at node, mg/ℓ.	STT	CSAT
			THE FOLLOWING VALUE REQUIRED IF ISWCH(8) = 1 ON CARD 31.		
		56-65	Reaeration coefficient at node, day^{-1}.	ATT	REAER
37	I5	1-5	Terminate card group 36 by writing 99999.		None
			IF NJSW $\geq$ 1 ON CARD 33 INCLUDE CARD GROUPS 38 AND 39.		
38			Stormwater input, NJSW (card 33) values (maximum = 20).		
	16I5	1-5	First junction for stormwater input.	JSW(1)	None
		6-10	Second junction for stormwater input.	JSW(2)	None
		.	.	.	
		.	.	.	
		.	.	.	
		.	Last junction for stormwater input.	JSW(NJSW)	None
			CARD GROUP 39 MUST BE READ IN GROUPS, EACH GROUP CONSISTING OF KCON NUMBER OF CARDS.		
39			Time and load rate (repeated sets of cards, each set consisting of KCON time groups).		
	8F10.0	1-10	Time of day, sec.[a]	TE	None
		11-20	Load rate of constituent for JSW(1), lbs/day (or MPN/min for coliforms).	CE(1)	None
		21-30	Load rate of constituent for JSW(2).	CE(2)	None
		.	.	.	
		.	.	.	
		.	.	.	
		.	Load rate of constituent for JSW(NJSW) lbs/day.	CE(NJSW)	None
40	F10.0	1-10	Terminate input pollutograph cards with TE beyond expected time of analysis.*		

* It is necessary to specify a TE, time and zero pollutant mass input to complete each pollutograph and avoid interpolation of final value to this time

TABLE 45. RECEIVING BLOCK VARIABLES[a]

Variable Name	C*	Description	Unit
A(I) **	C	Channel cross-section area at start of time-step	sq ft
AA(10)	C	Tidal curve fit coefficients during least square process	
AX(I)	C	Modified friction factor	
ALPHA (30)	C	Title for printing	
ALEN		Channel length	
ANAME		Input variable use for branching to either Quantity or Quality Block	
AREA		Computed nodal area to find initial nodal volume	
AS(J)	C	Node surface area	sq ft
AT(I)	C	Channel cross-section at midpoint of time-step	
		WEIR1 = Weir coefficient	
		WEIR2 = Elevation of weir crest	ft
		WEIR3 = Exponent in the expression $Q = WEIR1(H-WEIR2)^{WEIR3}$ where H is the water surface elevation and Q is the flow.	
ASTERK		Variable containing asterisk	
ATOT		Total surface area of receiving water	sq ft
AX(100,50)	C	Array containing X coordinates of plots	
AY(100,50)	C	Array containing Y coordinates of plots	
A1, A2, A3, A4, A5, A6, A7	C	Coefficients of the expression $H = A1 + A2COS(WT) + A3COS(2WT) + A4COS(3WT) + A5SIN(WT) + A6SIN(2WT) + A7SIN(3WT)$ for tidal input	
B(I)	C	Channel width	ft
BLANK		Variable containing blank	
C(J,6)	C	Constituent nodal concentrations	J=1,NJ K-1,KCON
CARD		Variable for reading second half of final card	
CE(6,20,2)	C	Storm water node input values of loading rate	lb/day
CF		Manning's coefficient for junction	
CLOSS		Constituent concentration lost to decay	
CMAX(J,6)	C	Daily maximum constituent concentration	mg/L
CMIN(J,6)	C	Daily minimum constituent concentration	mg/L
COEF		Manning's coefficient for channel	
COF(J)	C	Junction friction factor	
CPP		Steady state load rate for load node JTT	lb/day
CPPOX		Steady state DO inflow concentration	mg/L
CPRT(K)	C	Channel print array	
CS(6)	C	Conservative constituent concentration at controlled state-time node (JGW)	mg/L
CSAT(6)	C	DO constituent concentration at JGW	mg/L
CSPIN(J,6)	C	Initial constituent mass input levels	
CT(6,20,2)	C	Constituent loading rate from storm water input	lb/day
CTT		Initial node JTT constituents concentrations	mg/L
CTTOX		Initial node JTT DO concentrations	mg/L
C2(6)	C	Concentration at controlled stage-time node (JGW)	mg/L

[a] Does not include variables added during updating.

*Variable names shared in common blocks.

**In variable dimensions I is for number of channels, J is for number of junctions, and K is for number of point junctions, channels, and plots.

TABLE 45. (CONT'D)

Variable Name	C	Description	Unit
CURVE		Name of subroutine	
D		Dummy read variable	
DCDT(J,6)	C	Change of nodal concentration with time	
DECAY(6)	C	First order delay coefficient for non-conservative constituents	1/day
DELH		Increment of head of a junction for a time-step	ft
DELMAX		Maximum difference between the calculated and tidal stage input	ft
DELT	C	Time-step increment	
DELTA		Maximum allowable difference between the calculated and input tidal stage	ft
DELTQ	C	Length of quality time-step (usually an hour)	sec
DELT2		1/2 time-step increment	sec
DELV1, DELV2		Component of velocity change during a time-step	ft/sec
DEP(J)	C	Depth of water of a junction at zero datum	ft
DEPTH		Computed depth of node at a junction for initial volume	
DIFF		Difference between the calculated and input tidal stage	ft
DISOXY		Part of label for nonconservative constituents	mg/L
DT		Junction depth	ft
DUMMY		Dummy write variable to indicate end of data	
DVOL		Volume change in a time-step	cf
E2B		Total flow leaving system at tidal junction	cf
ENDER(2)		Array containing ENDQUANT to terminate model	
EVAP	C	Evaporation rate for whole system converted from ft/mo	cfs
FINAL		Variable for reading first half of final card	
FJ1		Internal variable	
FJ3		Internal variable	
FLOOD		Total flow entering system at tidal junction	cf
FWIND(I)	C	Drag force due to wind	
G		Channel length determined from X & Y coordinates	ft
H(J)	C	Head at junction at beginning of time-step	ft
HAVE(J)	C	Junction average head during a daily cycle	ft
HBAR(J)	C	Junction average head during a quality cycle	ft
HEAD		Distance water surface is from datum plane	ft
HN(J)	C	Junction head at end of time-step	ft
HORIZ	C	Graph horizontal axis title	
HOUR		Time-hours	hr
HPLT(K)	C	Array saved on scratch for later plotting	ft

TABLE 45. (CONT'D)

Variable Name	C*	Description	Unit
HT(J)	C	Junction head at end of 1/2 time-step	ft
IABS		Name of function	
IC		Internal variable	
ICOL	C	Printing column header	
ICON(6)		Bookkeeping integer for nonconservative constituents	
IDELT		Length of hydraulic cycle (integration step)	sec
IDUM	C	Column heading for channel printout	
II		Channel number	
INDATA		Name of subroutine	
INQUAL		Name of subroutine	
INRAIN		Number of rainfall inputs	
INSTM	C	Switch to cause reading of pollutograph from hydrograph file after one daily cycle	
INTIME(100)	C	Time of rainfall inputs	
IPERID		Length of tidal cycle	hrs
IPOINT(J,8)	C	Pointer array containing node to node connections	
IQINT		Length of quality cycle	sec
ISKIP	C	Printing counter	
ISW(20)	C	Storm water input junctions from hydrograph file	
ISWCH(10)	C	Control switches	
ITCPRT	C	Day cycle chosen for start of detailed quality printing	

Variable Name	C*	Description	Unit
JBOUND(20)	C	Junction with specified boundary conditions	
JGW	C	Junction with specified head flow or head relationships	
JH		Highest numbered junction at the end of a channel	
JJ		Lowest numbered junction at the end of the channel	
JJBOUN	C	Number of junctions with specified boundary conditions	
JPLT(K)	C	Array of junctions to be plotted	
JPRT(K)	C	Array of junctions for stage printout	
JSW(20)	C	Storm water input node numbers from cards	
JTT		Node number for special start conditions	
KCON	C	Number of constituents, including DO for nonconservative	
KCONO	C	Number of constituents	
KO		Switch to cause generation of a full tide from HHW, LLW, HLW, LHW	
KPRT	C	Counter for printing, standard output	
KRAIN		Counter for interpolation of rainfall input	
KSTART		Do loop start point for DO loop	
LEN(I)	C	Channel length	ft
LOOPQL		Name of subroutine	
LQCPRT	C	Desired total number of detailed quality print cycles	

TABLE 45. (CONT'D)

Variable Name	C*	Description	Unit
LTIME	C	Printing counter	
MADD(J,6)	C	Mass of nodal constituent	
MAXIT		Maximum number of iterations in tidal curve fit, usually 50	
MCOUNT		Card read counter at end of SWFLOW	
MCPR		Channel numbers for which flow and velocity are to be printed	
MINO		Name of function	
MJSW		Number of storm water input nodes from hydrograph file	
MJPRT		Junction numbers for which stage is to be printed	
MSTPRT	C	Printing counter for quality cycle, used in QPRINT	
MTOTAL		Printing counter, total hours printed	
NC	C	Number of channels	
NCHAN(J,8)	C	Channels associated with nodes	
NCHTID		Print control for tide generation	
NCL/S(I)	C	If equal to 1 channel dry, otherwise no effect	
NCON		Number of quality constituents on hydrograph input file	
NCURVE		Number of points on plotted curves	
NDC		Total number of curves	
NDRY		Number of dry junctions	
NEBB		Number of cycle with outflow at tide junction	
NEXIT	C	Set equal to 1 when error condition exists	
NFLD		Number of cycles with inflow at tide junction	
NH		Node at channel end	
NHCYC	C	Number of time-steps per quality cycle	
NHPRT	C	Number of junctions at which head will be printed	
NI		Number of tidal input values	
NINREC		Counter for tape storm water input	
NINT		Number of hydraulic cycles per tidal cycle	
NJ	C	Number of junctions	
NJSW	C	Number of storm water input junctions for cards	
NJUNC(I,2)	C	Nodes at channel ends	
NL		Node at channel end	
NPDEL	C	Number of time-steps per plot point	
NPLT	C	Number of points to be plotted	
NPRT	C	Standard output print interval, in days	
NPT	C	Number of parts on card curve	
NPTOT		Counter of time-steps for plotting	
NQ		Quality cycle counter	
NQCTOT	C	Printing counter	
NQCYC	C	Number of quality cycles per day	hr

TABLE 45. (CONT'D)

Variable Name	C*	Description	Unit
MQPRT	C	Quality cycle interval increments between detailed quality cycle prints (SWQUAL)	hr
MQSWRT	C	Number of daily cycles at which printing will start	
MSTEPS		Number of input records on input hydrograph file	
MSTART	C	Day DO loop start cycle	
MSTPRT	C	Printing counter, day cycle	
MT	C	Daily cycle number	
MTAG		Day, DO loop counter	
MTC	C	Number of day cycles	
MTCYC	C	Number of daily cycles to be simulated	
MTEMP(8)	C	Temporary array of channels entering a node	
MTIMS		Number of times through drying up connection	
MTINT	C	20 for first call to output 21 for subsequent calls	
MUNCH(I)	C	Array containing compacted form of junction connections	
MX		Number of curves to be plotted on one plot	
M5	C	Card reader	
M6	C	Printer	
M10	C	Scratch file number	
M20	C	SWFLOW-SWQUAL interfacing file	
M21	C	Input file containing hydrographs	
M22		Scratch file containing plot information	
M30	C	Restart input file	
M40	C	Output file	

Variable Name	C*	Description	Unit
OGAIN		Dissolved oxygen gained from reaeration	
PERIOD	C	Period in hours of daily cycle	hr
PREC		Instantaneous rainfall rate	ft/sec
PRTH(30,K)	C	Array for printing heads	ft
PRTOUT		Name of subroutine	
PRTQ(30,K)	C	Array for printing flows	cfs
PRTV(30,K)	C	Array for printing velocities	ft/sec
Q(I)	C	Channel flow	cfs
QAVE(I)	C	Daily cycle average flow	cfs
QBAR(I)	C	Quality cycle average flow	cfs
QE(20,2)	C	Inflows on input cards (subroutine SWFLOW)	cfs
QF	C	Total inflow to system through control node, 1-day cycle	cfs
QIN(J)	C	Inflows to junctions	cfs
QINBAR(J)	C	Quality cycle average junction inflow	cfs
QINST		Initial inflow to junction	cfs
QINT		Quality time-step interval	hr
QOU(J)	C	Outflow from junction	cfs
QOUBAR(J)	C	Quality cycle average junction outflow	cfs
QT(20,2)	C	Inflows from hydrograph input file	cfs
QUIN(J)		Flow into system at nodes	cfs
QUINST(J)		Instantaneous inflow rate	cfs
R(I)	C	Hydraulic radius	ft

TABLE 45. (CONT'D)

Variable Name	C*	Description	Unit
RAD		Channel depth measured from datum	ft
RAIN(100)	C	Rainfall hyetograph values	in/ft
REAER(6)	C	Reaeration coefficient	1/day
RES		Accumulative difference between the calculated and input tidal stage	ft
RNT		Temporary hydraulic radius at 1/2 time-step	ft
SIGN		Library function	
SLOPE	C	Instantaneous rate of change of inflow	ft/sec^2
SUM		Computed tidal stage	ft
SUMC(J,6)		Average daily nodal concentration	
SUMQ		Total flow leaving junction	cfs
SWFLOW		Name of subroutine	
SWQUAL		Name of subroutine	
SXX(10,10)	C	Matrix used for least square tidal fit	
SXY(10)	C	Vector used for least square tidal fit	
T	C	Time counter for whole analysis	sec
TDELT		Time-step of hydrograph input file	sec
TE	C	Time of inflow for card input	sec
TEMP		Simplifying variable used during solution of velocities	
TEO	C	Previous value of TE	sec
TEP	C	Time of inflow in hours	hr
TF		Estimate maximum time-step for channel	sec
TIME		Time counter for storm input	sec
TITEL2		Input hydrograph title	
TITLE(40)		Title array read from input hydrograph file	
TITLE(30)	C	Title array read from cards	
TITLESW(30)	C	Description of run	
TMAX		Dummy write variable to indicate end of data	
TOLD		Time of previous input rainfall	sec
TT(50)	C	Time from start of storm of input for tidal condition and from hydrograph file	sec
TTP		Times of previous input from hydrograph file	sec
TZ		Time of start of storm	hr
TZERO	C	Zero time for the analysis	sec
T2		Time at end of half hydraulic time-step	sec
U(225)	C	Channel velocity	
V	C	Channel velocity at start of time-step	ft/sec
VBAR	C	Average nodal volume during quality cycle	cf
VOL(J)	C	Nodal volume	cf
VOLO(J)	C	Volume of JGW	
VOLUME		Initial nodal volume	cf
VT	C	Channel velocity at 1/2 time-step	ft/sec
V2		Velocity during a half hydraulic time-step	ft/sec
W		Fundamental frequency of daily tidal variation	rad/sec

TABLE 45. (CONT'D)

Variable Name	C*	Description	Unit
WDIR	C	Wind direction in degrees from north	deg
WEIR1		Weir coefficient	
WEIR2		Elevation of weir crest	ft
WEIR3		Exponent in the expression Q = WEIR1 $(H-WEIR2)^{WEIR3}$ where H is the water surface elevation and Q is the flow	
WIDTH		Width of channel	ft
WIND	C	Wind force	mph
X(J)	C	X coordinate of junctions	ft
XMK		Blank or asterisk depending on whether estimated maximum time-step is satisfied	
XRQD	C	Mass exchange ratio of JGW	
XX(10)	C	Vector used in least square tidal fit	
Y(J)	C	Y coordinate of junctions	ft
YY(50)	C	Stage level of tidal input	ft

TABLE 46. RECEIVING SAMPLE INPUT DATA
(Corresponds to output in
Tables 17 to 50)

```
    RECEIVING
(1) QUANTITY/QUALITY
(2) TEST RIVER
(2) DISSOLVED OXYGEN PROFILE
(3) STORM INPUTS AT 3 POINTS
(3)
(4)       1
(5)       3   24     1   240      0      9      8      1                          1      5              7
(7)             1          2          3          4          5          6          7          8
(7)             9
(8)          1002       2003       3004       4005       5006       6007       7008       8009
(9)             1
(11)      1     4     50     1
(12)            0            8                 6                 8         12          8         18          8.
(15)      1     8          1.17     350          -.0005160          .013
          2     8          2.34                  -.0004515          .013
          3     8          2.34                  -.0003870          .013
          4     8          2.34                  -.0003225          .013
          5     8          2.34                  -.0002580          .013
          6     8          2.34                  -.0001935          .013
          7     8          2.34                  -.0001290          .013
          8     8          2.34                  -.0000645          .013
    (15)  9     8          1.17          350             0          .013
(16) 99999
(17)      1     1     2                          5280       440 -.0000838          .015          .05
          2     2     3                          5280       440 -.0000419          .015          .05
          3     3     4                          5280       440 -.0000354          .015          .05
          4     4     5                          5280       440 -.0000290          .015          .05
          5     5     6                          5280       440 -.0000258          .015          .05
          6     6     7                          5280       440 -.0000161          .015          .05
          7     7     8                          5280       440 -.0000968          .015          .05
(17)      8     8     9                          5280       440 -.0000322          .015          .05
(18) 99999
(19) STAGE V TIME AT JUNCTION 1
(20) TIME IN HOURS
(21) STAGE IN FT ABOVE DATUM
(22)      1     2     3
(23)            0           0           0           0
             3600         8.5         8.8         8.5
             7200        12.8        12.8        12.8
            10800         4.3         4.3         4.3
            14400         9.8         9.8         9.8
            18000         4.3         4.3         4.3
(23)        21600
(29)       500000
(30) EUTQUANT
    (31)                    1     1
    (32)  3     2     12      6
(33)      5     1     1
(34)      9           0     8.15E0 .1E0          BOD
(35) 99999
(37)      1     2     3
```

TABLE 46. (CONT'D)

(39)	0	0	0	0
	5500	88308	88008	88008
	7200	119544	119544	119544
	10400	136552	136552	136552
	14400	222176	222176	222176
	18000	26424	26424	26424
(39)	21600			
(40)	500300			

TABLE 47. INPUT DATA FOR QUANTITY SIMULATION

TEST RIVER
DISSOLVED OXYGEN PROFILE

E.P.A.
RECEIVING WATER HYDRODYNAMICS

DAYS SIMULATED 5

WATER QUALITY CYCLES PER DAY 24

INTEGRATION CYCLES PER WATER QUALITY CYCLE 15

LENGTH OF INTEGRATION STEP IS 240. SECONDS

INITIAL TIME 0.0 HOURS

EVAPORATION RATE, 0.0 INCHES PER MONTH

WIND VELOCITY, 0. MPH WIND DIRECTION, 0. DEGREES FROM NORTH

ESTURIAL SYSTEM

WRITE CYCLE STARTS AT THE 1 TIME CYCLE

NO PRECIPITATION INPUT

PRINTED OUTPUT AT THE FOLLOWING 9 JUNCTIONS

1 2 3 4 5 6 7 8 9

PRINTED OUTPUT FOR THE FOLLOWING 8 CHANNELS

1002 2003 3004 4005 5006 6007 7008 8009

KO IS 1 NUMBER OF TERMS IS 4 MAXIMUM NUMBER OF ITERATIONS IS 50 TIDE CHECK SWITCH IS 1

NO.	TIME	VALUE
1	0.0	0.000
2	6.000	0.000
3	12.000	0.000
4	18.000	0.000
5	1.500	0.000
6	3.000	0.000
7	4.500	0.000
8	7.500	0.000
9	9.000	0.000
10	10.500	0.000
11	13.500	0.000
12	15.000	0.000
13	16.500	0.000
14	19.500	0.000
15	21.000	0.000
16	22.500	0.000

TIME	OBSERVED	COMPUTED	DIFF
0.0	0.0000	0.0000	-0.0000
6.0000	0.0000	0.0000	-0.0000
12.0000	0.0000	0.0000	-0.0000

TABLE 47. (CONT'D)

18.0000	0.0000	0.0000	-0.0000
1.5000	0.0000	0.0000	-0.0000
3.0000	0.0000	0.0000	-0.0000
4.5000	0.0000	0.0000	-0.0000
7.5000	0.0000	0.0000	-0.0000
9.0000	0.0000	0.0000	-0.0000
10.5000	0.0000	0.0000	-0.0000
13.5000	0.0000	0.0000	-0.0000
15.0000	0.0000	0.0000	-0.0000
16.5000	0.0000	0.0000	-0.0000
19.5000	0.0000	0.0000	-0.0000
21.0000	0.0000	0.0000	-0.0000
22.5000	0.0000	0.0000	-0.0000
TOTAL			0.0001

COEFFICIENTS FOR TIDAL INPUT WAVE AT JUNCTION 9

A1	A2	A3	A4	A5	A6	A7	PERIOD(HRS)
8.000	-0.000	0.000	0.000	-0.000	0.000	-0.000	24.00

WHERE THE WAVEFORM IS GIVEN BY

H(J) = A1 + A2.SIN(WT) + A3.SIN(2WT) + A4.SIN(3WT) + A5.COS(WT) + A6.COS(2WT) + A7.COS(3WT)

* * * * * C H A N N E L D A T A * * * * *

CHANNEL NUMBER	LENGTH (FT)	WIDTH (FT)	AREA (SQ FT)	MANNING COEF.	VELOCITY (FPS)	HYD RADIUS (FT)	JUNCTIONS AT ENDS		MAX TIME STEP (SEC)	EXCEEDED BY STEP OF 240
1	5280.	440.00	3520.	0.013	0.05	8.0	1	2	319.	
2	5280.	440.00	3520.	0.013	0.05	8.0	2	3	319.	
3	5280.	440.00	3520.	0.013	0.05	8.0	3	4	319.	
4	5280.	440.00	3520.	0.013	0.05	8.0	4	5	319.	
5	5280.	440.00	3520.	0.013	0.05	8.0	5	6	319.	
6	5280.	440.00	3520.	0.013	0.05	8.0	6	7	319.	
7	5280.	440.00	3520.	0.013	0.05	8.0	7	8	319.	
8	5280.	440.00	3520.	0.013	0.05	8.0	8	9	319.	

* * * * * J U N C T I O N D A T A * * * * *

JUNCTION NUMBER	INITIAL HEAD (FT)	DEPTH (FT)	SURFACE AREA (10**6 SQ FT)	INPUT (CFS)	OUTPUT (CFS)	CHANNELS ENTERING JUNCTION											COORDINATES X	Y
1	8.00	-0.0	1.17	350.	0.	1	0	0	0	0	0	0	0	0	0	0	0.0	0.0
2	8.00	-0.0	2.34	0.	0.	2	1	0	0	0	0	0	0	0	0	0	0.0	0.0
3	8.00	-0.0	2.34	0.	0.	3	2	0	0	0	0	0	0	0	0	0	0.0	0.0
4	8.00	-0.0	2.34	0.	0.	4	3	0	0	0	0	0	0	0	0	0	0.0	0.0
5	8.00	-0.0	2.34	0.	0.	5	4	0	0	0	0	0	0	0	0	0	0.0	0.0
6	8.00	-0.0	2.34	0.	0.	6	5	0	0	0	0	0	0	0	0	0	0.0	0.0
7	8.00	-0.0	2.34	0.	0.	7	6	0	0	0	0	0	0	0	0	0	0.0	0.0
8	8.00	-0.0	2.34	0.	0.	8	7	0	0	0	0	0	0	0	0	0	0.0	0.0
9	8.00	0.0	1.17	0.	350.	8	0	0	0	0	0	0	0	0	0	0	0.0	0.0

TOTAL AREA FOR THE SYSTEM 18.72 * 10**6 SQ FT OR 0.67 SQ MILES

TABLE 48. OUTPUT DATA FOR QUANTITY SIMULATION

TEST RIVER
DISSOLVED OXYGEN PROFILE

E.P.A.
RECEIVING WATER HYDRODYNAMICS

STORM INPUTS AT 3 NODES

DAY IS 1

* TIME HISTORY OF STAGE *

HOUR	JUNCTION 1 HEAD(FEET)	JUNCTION 2 HEAD(FEET)	JUNCTION 3 HEAD(FEET)	JUNCTION 4 HEAD(FEET)	JUNCTION 5 HEAD(FEET)	JUNCTION 6 HEAD(FEET)
0.0	8.0000	8.0000	8.0000	8.0000	8.0000	8.0000
1.00	8.0260	8.0257	8.0251	8.0236	8.0202	8.0146
2.00	7.9811	7.9809	7.9809	7.9819	7.9842	7.9879
3.00	8.0038	8.0036	8.0031	8.0024	8.0016	8.0010
4.00	8.0197	8.0190	8.0176	8.0155	8.0128	8.0097
5.00	7.9851	7.9851	7.9856	7.9867	7.9883	7.9906
6.00	8.0052	8.0049	8.0044	8.0037	8.0029	8.0021
7.00	8.0139	8.0133	8.0123	8.0108	8.0089	8.0068
8.00	7.9888	7.9888	7.9892	7.9901	7.9914	7.9931
9.00	8.0057	8.0054	8.0049	8.0042	8.0035	8.0026
10.00	8.0097	8.0093	8.0085	8.0075	8.0063	8.0048
11.00	7.9920	7.9919	7.9922	7.9928	7.9938	7.9950
12.00	8.0057	8.0054	8.0049	8.0043	8.0036	8.0027
13.00	8.0069	8.0065	8.0060	8.0052	8.0044	8.0034
14.00	7.9945	7.9943	7.9945	7.9949	7.9956	7.9965
15.00	8.0054	8.0051	8.0046	8.0041	8.0034	8.0026
16.00	8.0050	8.0047	8.0042	8.0037	8.0031	8.0024
17.00	7.9964	7.9963	7.9963	7.9966	7.9970	7.9976
18.00	8.0050	8.0047	8.0043	8.0037	8.0031	8.0024
19.00	8.0037	8.0034	8.0031	8.0027	8.0022	8.0017
20.00	7.9979	7.9978	7.9977	7.9979	7.9981	7.9985
21.00	8.0045	8.0042	8.0038	8.0034	8.0028	8.0022
22.00	8.0029	8.0026	8.0023	8.0020	8.0016	8.0012
23.00	7.9991	7.9989	7.9988	7.9988	7.9989	7.9991
24.00	8.0041	8.0038	8.0034	8.0030	8.0025	8.0019

TABLE 48. (CONT'D)

TEST RIVER
DISSOLVED OXYGEN PROFILE

E.P.A.
RECEIVING WATER HYDRODYNAMICS

STORM INPUTS AT 3 NODES

DAY IS 1

* T I M E H I S T O R Y O F F L O W A N D V E L O C I T Y * * * * * * * * * * * * * * * * * * *

HOUR	CHANNEL 1 2 FLOW (CFS)	1 2 VEL. (FPS)	CHANNEL 2 3 FLOW (CFS)	2 3 VEL. (FPS)	CHANNEL 3 4 FLOW (CFS)	3 4 VEL. (FPS)	CHANNEL 4 5 FLOW (CFS)	4 5 VEL. (FPS)	CHANNEL 5 6 FLOW (CFS)	5 6 VEL. (FPS)	CHANNEL 6 7 FLOW (CFS)	6 7 VEL. (FPS)
0.0	0.	0.05	0.	0.05	0.	0.05	0.	0.05	0.	0.05	0.	0.05
1.00	350.	0.10	349.	0.10	352.	0.10	362.	0.10	386.	0.11	427.	0.12
2.00	350.	0.10	353.	0.10	360.	0.10	377.	0.11	404.	0.11	434.	0.12
3.00	326.	0.09	283.	0.08	249.	0.07	226.	0.06	214.	0.06	209.	0.06
4.00	354.	0.10	363.	0.10	375.	0.11	390.	0.11	407.	0.12	425.	0.12
5.00	352.	0.10	358.	0.10	366.	0.10	375.	0.11	387.	0.11	398.	0.11
6.00	336.	0.10	310.	0.09	287.	0.08	268.	0.08	254.	0.07	245.	0.07
7.00	356.	0.10	368.	0.10	390.	0.11	392.	0.11	403.	0.12	414.	0.12
8.00	353.	0.10	356.	0.10	361.	0.10	366.	0.10	371.	0.10	376.	0.11
9.00	341.	0.10	323.	0.09	307.	0.09	293.	0.08	282.	0.08	274.	0.08
10.00	355.	0.10	366.	0.10	377.	0.11	387.	0.11	395.	0.11	403.	0.11
11.00	351.	0.10	353.	0.10	356.	0.10	358.	0.10	360.	0.10	362.	0.10
12.00	344.	0.10	332.	0.09	320.	0.09	311.	0.09	302.	0.09	296.	0.08
13.00	355.	0.10	364.	0.10	372.	0.11	380.	0.11	387.	0.11	393.	0.11
14.00	350.	0.10	351.	0.10	352.	0.10	352.	0.10	353.	0.10	353.	0.10
15.00	346.	0.10	337.	0.10	330.	0.09	323.	0.09	317.	0.09	312.	0.09
16.00	354.	0.10	361.	0.10	368.	0.10	374.	0.11	380.	0.11	384.	0.11
17.00	350.	0.10	349.	0.10	349.	0.10	349.	0.10	349.	0.10	348.	0.10
18.00	347.	0.10	341.	0.10	336.	0.10	331.	0.09	327.	0.09	324.	0.09
19.00	353.	0.10	359.	0.10	364.	0.10	369.	0.10	373.	0.11	376.	0.11
20.00	350.	0.10	349.	0.10	348.	0.10	347.	0.10	346.	0.10	346.	0.10
21.00	348.	0.10	344.	0.10	341.	0.10	337.	0.10	335.	0.10	332.	0.09
22.00	352.	0.10	357.	0.10	361.	0.10	365.	0.10	368.	0.10	370.	0.11
23.00	349.	0.10	348.	0.10	347.	0.10	346.	0.10	345.	0.10	345.	0.10
24.00	349.	0.10	346.	0.10	344.	0.10	342.	0.10	340.	0.10	338.	0.10

TABLE 49. INPUT DATA FOR QUALITY SIMULATION

STORM INPUTS AT 3 NODES

TEST RIVER
DISSOLVED OXYGEN PROFILE

E.P.A.
DYNAMIC STORM WATER QUALITY

MAXIMUM JUNCTION NUMBER 9

MAXIMUM CHANNEL NUMBER 8

NUMBER OF QUALITY CYCLES PER DAY 24

NUMBER OF DAYS 5

NUMBER OF CONSTITUENTS 1

LENGTH OF QUALITY INTEGRATION STEP (SECONDS) 3600.

PRINT INTERVAL, 1 DAYS

EXCHANGE REQUIREMENT AT OCEAN = RATIO OF ESTUARINE FLOW RETURNED TO AMOUNT THAT FLOWS OUT, PER TIDAL CYCLE 0.0

AVERAGE WATER TEMPERATURE (DEGREES CENTIGRADE) 0.0

THERE ARE 3 STORMWATER INPUT JUNCTIONS

QUALITY CYCLE CONCENTRATIONS, PRINTOUT STARTS IN TIME CYCLE 2 ,

PRINTED EVERY 12 HOUR(S), FOR A TOTAL OF 72 HOURS.

* * * * * SWITCH SETTINGS * * * * *

SWITCH NUMBER	1	2	3	4	5	6	7	8	9	10
SWITCH SETTING	0	0	0	1	1	0	0	0	0	0

INITIAL DISSOLVED OXYGEN CONCENTRATIONS (MGL), BY JUNCTION

	1	2	3	4	5	6	7	8	9	10
JUNCTION 1 TO 9	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	

DISSOLVED OXYGEN CONCENTRATION OF INFLOW (MGL), JUNCTION

	1	2	3	4	5	6	7	8	9	10
JUNCTION 1 TO 9	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	

TABLE 49. (CONT'D)

CONSTITUENT NUMBER 1 BOD

SINK CONCENTRATION, MGL (OR MPN/L) 0.0

OXYGEN SATURATION (MGL) 8.00

REAERATION COEFFICIENT (1/DAY) 0.150

DECAY COEFFICIENT (1/DAY) 0.10

DISSOLVED OXYGEN FOR THIS CONSTITUENT IS CONSTITUENT 2

INITIAL CONCENTRATIONS, MGL (OR MPN/L), BY JUNCTION

	1	2	3	4	5	6	7	8	9	10
JUNCTION 1 TO 9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

MASS LOADINGS, THOUSANDS OF LBS/DAY (OR OF MPN/MIN), BY JUNCTION

	1	2	3	4	5	6	7	8	9	10
JUNCTION 1 TO 9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

TABLE 50. OUTPUT DATA FOR QUALITY SIMULATION

STORM INPUTS AT 3 NODES

TEST RIVER
DISSOLVED OXYGEN PROFILE

E.P.A.
DYNAMIC STORM WATER QUALITY

AVERAGE JUNCTION CONCENTRATIONS, MGL (OR MPN/L), DURING TIDAL OR TIME CYCLE 1, CONSTITUENT NUMBER 2 BOD (DO)

JUNCTION	1	2	3	4	5	6	7	8	9	10
1 TO 9	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01

MAXIMUMS

JUNCTION										
1 TO 9	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01

MINIMUMS

JUNCTION										
1 TO 9	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01

INPUT, POUNDS PER DAY, CONSTITUENT NUMBER 1 AT 1.00 HOURS OR 0.04 DAYS FROM START

JUNCTION	LBS/DAY
1	0.880E 05
2	0.880E 05
3	0.880E 05

INPUT, POUNDS PER DAY, CONSTITUENT NUMBER 1 AT 2.00 HOURS OR 0.08 DAYS FROM START

JUNCTION	LBS/DAY
1	0.120E 06
2	0.120E 06
3	0.120E 06

INPUT, POUNDS PER DAY, CONSTITUENT NUMBER 1 AT 3.00 HOURS OR 0.13 DAYS FROM START

JUNCTION	LBS/DAY
1	0.137E 06
2	0.137E 06
3	0.137E 06

INPUT, POUNDS PER DAY, CONSTITUENT NUMBER 1 AT 4.00 HOURS OR 0.17 DAYS FROM START

JUNCTION	LBS/DAY
1	0.222E 07
2	0.222E 07
3	0.222E 07

INPUT, POUNDS PER DAY, CONSTITUENT NUMBER 1 AT 5.00 HOURS OR 0.21 DAYS FROM START

JUNCTION	LBS/DAY
1	0.264E 05
2	0.264E 05
3	0.264E 05

INPUT, POUNDS PER DAY, CONSTITUENT NUMBER 1 AT 6.00 HOURS OR 0.25 DAYS FROM START

JUNCTION	LBS/DAY
1	0.0

TABLE 50. (CONT'D)

TEST RIVER
DISSOLVED OXYGEN PROFILE

EPA STORMWATER MODEL
RECEIVING WATER QUALITY

STORM INPUTS AT 3 NODES

JUNCTION CONCENTRATIONS, MGL (OR MPN/L), DURING TIME CYCLE (DAY) 2, QUALITY CYCLE 12, TIME (SEC) 43200.

CONSTITUENT NUMBER 1 BOD

	1	2	3	4	5	6	7	8	9	10
JUNCTION 1 TO 9	54.15	96.08	93.25	40.25	9.52	1.40	0.14	0.01	0.00	

CONSTITUENT NUMBER 2 BOD (DO)

	1	2	3	4	5	6	7	8	9	10
JUNCTION 1 TO 9	5.91	4.27	4.37	6.42	7.62	7.94	7.99	8.00	8.00	

JUNCTION CONCENTRATIONS, MGL (OR MPN/L), DURING TIME CYCLE (DAY) 2, QUALITY CYCLE 24, TIME (SEC) 86400.

CONSTITUENT NUMBER 1 BOD

	1	2	3	4	5	6	7	8	9	10
JUNCTION 1 TO 9	9.09	52.65	78.71	65.15	35.20	13.52	3.90	0.87	0.16	

CONSTITUENT NUMBER 2 BOD (DO)

	1	2	3	4	5	6	7	8	9	10
JUNCTION 1 TO 9	7.21	3.39	1.11	2.29	4.91	6.81	7.66	7.92	7.99	

TABLE 50. (CONT'D)

TEST RIVER
DISSOLVED OXYGEN PROFILE

EPA STORMWATER MODEL
RECEIVING WATER QUALITY

STORM INPUTS AT 3 NODES

JUNCTION CONCENTRATIONS, MGL (OR MPN/L), DURING TIME CYCLE (DAY) 4, QUALITY CYCLE 12, TIME (SEC) 216000.

CONSTITUENT NUMBER 1 BOD

	1	2	3	4	5	6	7	8	9	10
JUNCTION 1 TO 9	0.04	4.21	15.95	32.05	44.67	45.33	35.52	23.27	12.96	

CONSTITUENT NUMBER 2 BOD (DO)

	1	2	3	4	5	6	7	8	9	10
JUNCTION 1 TO 9	7.99	7.05	4.39	1.08	0.05	0.05	0.69	2.91	5.10	

JUNCTION CONCENTRATIONS, MGL (OR MPN/L), DURING TIME CYCLE (DAY) 4, QUALITY CYCLE 24, TIME (SEC) 259200.

CONSTITUENT NUMBER 1 BOD

	1	2	3	4	5	6	7	8	9	10
JUNCTION 1 TO 9	0.01	1.74	8.04	19.43	32.27	40.79	39.38	30.67	20.58	

CONSTITUENT NUMBER 2 BOD (DO)

	1	2	3	4	5	6	7	8	9	10
JUNCTION 1 TO 9	8.00	7.53	5.82	2.88	0.36	0.05	0.05	0.70	2.74	

TABLE 50. (CONT'D)

STORM INPUTS AT 3 NODES

TEST RIVER
DISSOLVED OXYGEN PROFILE

E.P.A.
DYNAMIC STORM WATER QUALITY

AVERAGE JUNCTION CONCENTRATIONS, MGL (OR MPN/L), DURING TIDAL OR TIME CYCLE 2, CONSTITUENT NUMBER 1 BOD

	1	2	3	4	5	6	7	8	9	10
JUNCTION 1 TO 9	0.528E 02	0.736E 02	0.776E 02	0.354E 02	0.124E 02	0.339E 01	0.741E 00	0.132E 00	0.193E-01	
					MAXIMUMS					
JUNCTION 1 TO 9	0.176E 03	0.104E 03	0.933E 02	0.651E 02	0.352E 02	0.135E 02	0.390E 01	0.875E 00	0.157E 00	
					MINIMUMS					
JUNCTION 1 TO 9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

AVERAGE JUNCTION CONCENTRATIONS, MGL (OR MPN/L), DURING TIDAL OR TIME CYCLE 2, CONSTITUENT NUMBER 2 BOD

	1	2	3	4	5	6	7	8	9	10
JUNCTION 1 TO 9	0.660E 01	0.497E 01	0.453E 01	0.598E 01	0.720E 01	0.776E 01	0.795E 01	0.799E 01	0.800E 01	
					MAXIMUMS					
JUNCTION 1 TO 9	0.796E 01	0.798E 01	0.798E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	0.800E 01	
					MINIMUMS					
JUNCTION 1 TO 9	0.578E 01	0.324E 01	0.111E 01	0.229E 01	0.491E 01	0.681E 01	0.766E 01	0.792E 01	0.799E 01	

TABLE 50. (CONT'D)

STORM INPUTS AT 3 NODES

TEST RIVER
DISSOLVED OXYGEN PROFILE

E.P.A.
DYNAMIC STORM WATER QUALITY

AVERAGE JUNCTION CONCENTRATIONS, MGL (OR MPN/L), DURING TIDAL OR TIME CYCLE 4, CONSTITUENT NUMBER 1 BOD

JUNCTION	1	2	3	4	5	6	7	8	9	10
1 TO 9	0.698E-01	0.477E 01	0.170E 02	0.327E 02	0.440E 02	0.39E 02	0.346E 02	0.229E 02	0.131E 02	

MAXIMUMS

JUNCTION										
1 TO 9	0.221E 00	0.942E 01	0.206E 02	0.470E 02	0.526E 02	0.454E 02	0.394E 02	0.307E 02	0.206E 02	

MINIMUMS

JUNCTION										
1 TO 9	0.721E-02	0.174E 01	0.804E 01	0.194E 02	0.323E 02	0.408E 02	0.265E 02	0.138E 02	0.600E 01	

AVERAGE JUNCTION CONCENTRATIONS, MGL (OR MPN/L), DURING TIDAL OR TIME CYCLE 4, CONSTITUENT NUMBER 2 BOD

JUNCTION	1	2	3	4	5	6	7	8	9	10
1 TO 9	0.799E 01	0.698E 01	0.432E 01	0.121E 01	0.809E-01	0.118E 00	0.102E 01	0.297E 01	0.501E 01	

MAXIMUMS

JUNCTION										
1 TO 9	0.800E 01	0.753E 01	0.582E 01	0.288E 01	0.361E 00	0.610E 00	0.300E 01	0.531E 01	0.690E 01	

MINIMUMS

JUNCTION										
1 TO 9	0.795E 01	0.617E 01	0.256E 01	0.540E-01	0.490E-01	0.492E-01	0.491E-01	0.698E 00	0.274E 01	

APPENDIX A

DATA ANALYSIS PROGRAM

USER'S MANUAL

DATA ANALYSIS PROGRAM

A.1 Introduction

The meteorological data requirements of both the SWMM and STORM models may be quite extensive, depending upon the number of events simulated and the degree of modelling detail. The STORM model usually employs several years of hourly precipitation and temperature as a data base, while the SWMM requires short interval (often five minutes) rainfall data for each event simulated. Organization of large amounts of meteorological data will often be necessary, creating opportunities for both random and systematic errors which may lead to poor simulation and greater de-bugging efforts. The most important source of meteorological data for real storm simulation is the Atmospheric Environment Service (AES), a division of Fisheries and Environment Canada.

The Data Analysis Program was developed to interface the Urban Runoff models with existing meteorological data banks, and to create and manage a data base of precipitation and temperature data. The program is capable of operating on hourly data and also on short interval data with any specified time and volume units. However, since the preparation of input data for the SWMM is not too onerous a task, it is expected that the major benefit of this program will be to prepare large amounts of hourly data for use with STORM. It uses data from the Climatological Data Bank of the Atmospheric Environment Service. Data may be supplied on cards, tape or disc storage forms, but the data sets are referred to as Card Type 3 (or 4) Data.

The Data Analysis Program is made up of three separate programs which may be used individually or in combination to perform the desired operations. Disc storage is used during the processing within each program, and cards, tape or disc may be used to store output from each. Together, the three programs may be used to perform the following tasks:

1) Read, screen and punch hourly rainfall data from AES tapes into the format suitable for input to STORM

2) Combine, plot, perform mass curve analysis on several gauge records, punch in format for SWMM or STORM input, and summarize storm events.

A.2 Computer System Requirements

The Data Analysis Programs can be run on a machine having core storage capacity of at least 150K bytes (or equivalent). In addition, the program uses peripheral storage devices which may consist of disc, tape or drum units, depending on the machine configuration.

A.3 Job Control Language (JCL)

The assignment of logical units requires, in general, the provision for files to be written on specific physical devices. To accomplish this, the user must supply the necessary JCL. As a rule, JCL is highly machine dependent; in fact, it often differs on two identical machines at different installations. Therefore, the Data Analysis Program cannot include JCL that is universally applicable. The following remarks, however, may be useful in gaining an insight into what is involved on systems such as an IBM 370/168.

Of the three programs, the Data Bank Processing program requires the most extensive job control instructions. Thus, a sample of the required JCL for this program suitable for an IBM 370/168 is given in Table A.1. The following is a description of the logical unit numbers used in Table A.1.

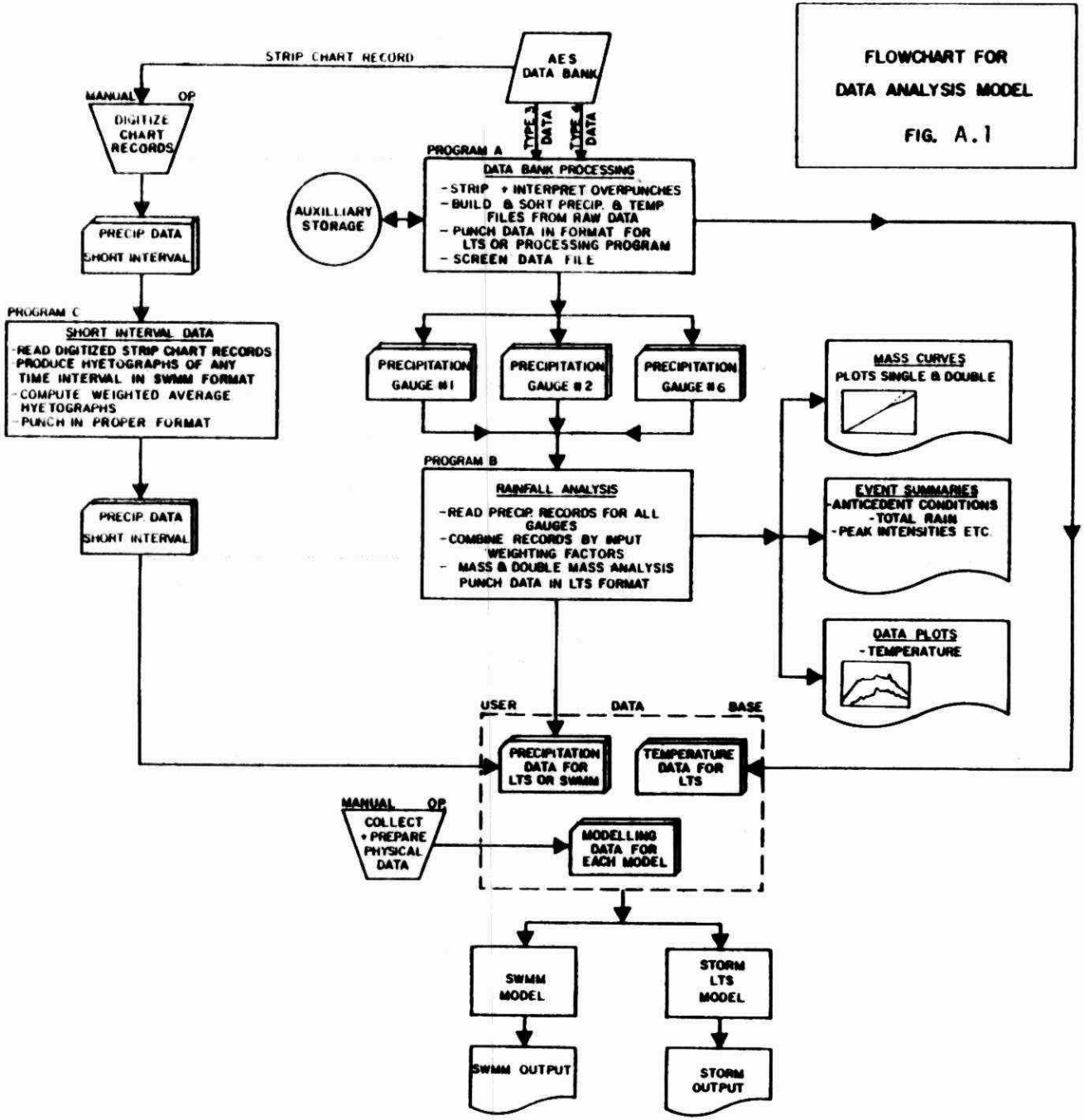
- Units 1 and 2 are scratch data sets.
- Units 3 and 4 contain the information from the AES in either card or tape form.
- Units 5, 6 and 7 are the reader, printer and card punch, respectively.
- It should be noted that a disc sort of Units 1 and 2 is required for the field comprised of columns 1 through 7. Most computer facilities have a disc sort utility available.

A.4 Program Operation

Figure A.1 shows the relationships between three programs. The "Data Bank Processing" (DBP) program reads data directly from AES data bank, performs reading and screening functions and outputs processed precipitation and temperature data. This data may be directly entered into the user data base or input to the "Rainfall Analysis Program" (RAP) for

TABLE A.1. SAMPLE JCL FOR DATA BANK PROCESSING PROGRAM

```
0001  //DAP    JOB     (PR930),PATAKY
0002  //DBA  EXEC  F4HCLM,PARM.FORT='SIZE=300K,NOSOURCE,NOMAP',
0003  //         PARM.LKED='LIST,MAP,LET'
0004  //FORT.SYSIN  DD  UNIT=TAPE9,VOL=SER=MASTER,DSN=AES1,
0005  //         DISP=(OLD,PASS),LABEL=8
0006  //GO.FT01F001  DD  UNIT=SYSDA,SPACE=(TRK,(10,10)),DSN=&RAIN,
0007  //         DISP=(,PASS),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
0008  //GO.FT02F001  DD  UNIT=SYSDA,SPACE=(TRK,(10,10)),DSN=&TEMP,
0009  //         DISP=(,PASS),DCB=(RECFM=FB,LRECL=20,BLKSIZE=800)
0010  //FT03F001  DD  DSN=AESTYPE3,VOL=SER=111111,LABEL=(2,BLP,IN),
0011  //         UNIT=(DUAL,,DEFER),DCB=(LRECL=80,RECFM=FB,
0012  //         BLKSIZE=1600,DEN=2)
0013  //FT04F001  DD  DSN=AESTYPE4,VOL=SER=111111,LABEL=(4,BLP,,IN),
0014  //         UNIT=(DUAL,,DEFER),DCB=(LRECL=80,RECFM=FB,
0015  //         BLKSIZE=1600,DEN=2)
0016  //FT06F001  DD  SYSOUT=A
0017  //FT07F001  DD  SYSOUT=B
0018  //FT05F001  DD  *
      (DATA BANK PROCESSING CARD GROUP 1)
0019  //SORTFT01  EXEC  SORTD3
0020  //SORT.SORTIN  DD  DSN=&RAIN, DISP=(OLD,DELETE)
0021  //SORT.SORTOUT  DD  DSN=&SRAIN,DISP=(,PASS),UNIT=SYDA,
0022  //         SPACE=(TRK,(10,10)),DCB=RECFM=FB,LRECL=80,BLKSIZE=800)
0023  //SORT.SYSIN  DD  *
0024  //SORT FIELDS=(1.0,7.0,CH,A),SIZE=E1200
0025  //SORTFT02  EXEC  SORTD3
0026  //SORT.SORTIN  DD  DSN=&TEMP,DISP=(OLD,DELETE)
0027  //SORT.SORTOUT  DD  DSN=&STEMP,DISP=(,PASS),UNIT=SYSDA,
0028  //         SPACE=(TRK,(10,10)),DCB=(RECFM=FB,LRECL=20,BLKSIZE=800)
0029  //SORT.SYSIN  DD  *
0030    SORT FIELDS=(1.0,7.0,CH,A),SIZE=E1200
0031  //DBP1  EXEC  F4HCLM,PARM.FORT='SIZE=300K,NOSOURCE,NOMAP',
0032  //         PARM.LKED=LIST,MAP.LET'
0033  //FORT.SYSIN  DD  UNIT=TAPE9,VOL=SER=MASTER,DSN=AES2,
0034  //         DISP=(OLD,PASS),LABEL=9
0035  //GO.FT01F001  DD  DSN=&SRAIN,DISP=(OLD,DELETE)
0036  //FO.FT01F001  DD  DSN=&STEMP,DISP=(OLD,DELETE)
0037  //FT06F001  DD  SYSOUT=A
0038  //FT07F001  DD  SYSOUT=B
0039  //FT05F001  DD  *
      (DATA BANK PROCESSING CARD GROUPS 4 AND 5)
```


FLOWCHART FOR
DATA ANALYSIS MODEL
FIG. A.1
STRIP CHART RECORD
AES
DATA BANK
TYPE 3 DATA
TYPE 4 DATA
MANUAL OP
DIGITIZE CHART RECORDS
PRECIP DATA SHORT INTERVAL
PROGRAM A
DATA BANK PROCESSING
- STRIP + INTERPRET OVERPUNCHES
- BUILD & SORT PRECIP. & TEMP FILES FROM RAW DATA
- PUNCH DATA IN FORMAT FOR LTS OR PROCESSING PROGRAM
- SCREEN DATA FILE
AUXILLIARY STORAGE
PROGRAM C
SHORT INTERVAL DATA
-READ DIGITIZED STRIP CHART RECORDS PRODUCE HYETOGRAPHS OF ANY TIME INTERVAL IN SWMM FORMAT
-COMPUTE WEIGHTED AVERAGE HYETOGRAPHS
-PUNCH IN PROPER FORMAT
PRECIPITATION GAUGE #1
PRECIPITATION GAUGE #2
PRECIPITATION GAUGE #6
MASS CURVES
PLOTS SINGLE & DOUBLE
PROGRAM B
RAINFALL ANALYSIS
-READ PRECIP RECORDS FOR ALL GAUGES
-COMBINE RECORDS BY INPUT WEIGHTING FACTORS
- MASS & DOUBLE MASS ANALYSIS PUNCH DATA IN LTS FORMAT
EVENT SUMMARIES
-ANTICEDENT CONDITIONS
-TOTAL RAIN
-PEAK INTENSITIES ETC
PRECIP DATA SHORT INTERVAL
DATA PLOTS
-TEMPERATURE
USER DATA BASE
PRECIPITATION DATA FOR LTS OR SWMM
TEMPERATURE DATA FOR LTS
MANUAL OP
COLLECT + PREPARE PHYSICAL DATA
MODELLING DATA FOR EACH MODEL
SWMM MODEL
STORM LTS MODEL
SWMM OUTPUT
STORM OUTPUT

further processing. The "Short Interval Rain Data Processing" (SIP) program operates independently of the other two programs, and uses manually digitized recording rain gauge data as input.

The first two programs (DBP and RAP) operate on hourly data contained in the AES data bank. These programs satisfy the long-term simulation data requirements for precipitation and temperature, and provide output in a format suitable for direct input into the STORM program. The third program processes rainfall data of any time interval, and its output is in SWMM format.

A.5 Data Bank Processing

The AES data bank uses 21 card types, or data formats, to contain the entire climatological archives. Of these card formats, Card Type 3 and Type 4 contain the hourly precipitaion and maximum/minimum temperature data required for modelling, and are used as input to the Data Analysis Program. These raw data may be ordered from the Atmospheric Environment Service either on tape or cards for the desired period. The card formats are given in detail in Appendix B.

A.5.1 Card Type 3 - Recording precipitation gauge data

This card contains total precipitation, hourly precipitation, and maximum precipitation amounts for specified durations, for each day. Type 3 data are available for over 400 stations in Canada. The hourly rainfall data on this card are used by the Data Analysis Program. Most recording rain gauges in Canada operate from April through October. For continuous simulation outside of this period, the precipitation record must be filled in with data from another source, the Type 4 Card.

A.5.2 Card Type 4 - Summary for the climatological day

This card contains data on temperature, relative humidity, precipitation snow depth, weather and wind. Six or twelve-hour rainfall is recorded from standard rain gauges, and snowfall is reported separately. The rainfall data on this card is used in cases where Type 3 data are missing or during period while the recording gauge is shut down. The maximum and minimum temperatures for the day, as well as snowfall, are used in snowmelt computations.

A.5.3 Input and processing

Figure A.2 shows a functional flow chart for the Data Bank Processing Program.

The Data Bank Processing Program first reads and prints the desired starting and ending date for reading and processing the data. The program then reads Type 3 Card data on either cards, tape, or disc, and senses over-punches (used for freezing precipitation). Freezing rain is flagged with a printed message, and the program assumes zero rainfall in that hour. This "zero" hour may be subsequently revised if valid Type 4 data are available for that day. It should be noted, however, that Type 3 data may be processed even if Type 4 data are unavailable and that non-zero Type 3 data are always used in preference to Type 4 data. The program then stores the precipitation file on disc. Next, the Type 4 data are read and checked for overpunches, invalid characters, and are stored in a second working file. These files, which contain the screened Type 3 and Type 4 data, are then sorted into chronological order.

The program then reads in a job title, and start and end dates for further data processing. These may be different from those used for reading the raw data. Maximum and minimum values for temperatures are read to check for obvious keypunching errors. Default maximum, minimum, and average temperatures are read in to be used when temperature data are missing for a particular day. Finally, output plotting and punch controls are read in.

The program then proceeds to read the screened Type 3 and Type 4 data from the working files. These data are then combined to create the screened and processed precipitation file. This is done by calculating the cumulative six-hour rainfall for Type 3 data and comparing it to the corresponding Type 4 information. If it is less than the Type 4 data, an hour-by-hour scan of the Type 3 data is conducted for hours of zero precipitation. If these are detected then a uniform amount of rainfall is added to each of these "zero" hours such that the six-hour Type 3 total will equal the Type 4 total. In this manner, the Type 3 hourly precipitation record is supplemented to correct for missing or invalid data previously set to zero during the screening process. If Type 4 data

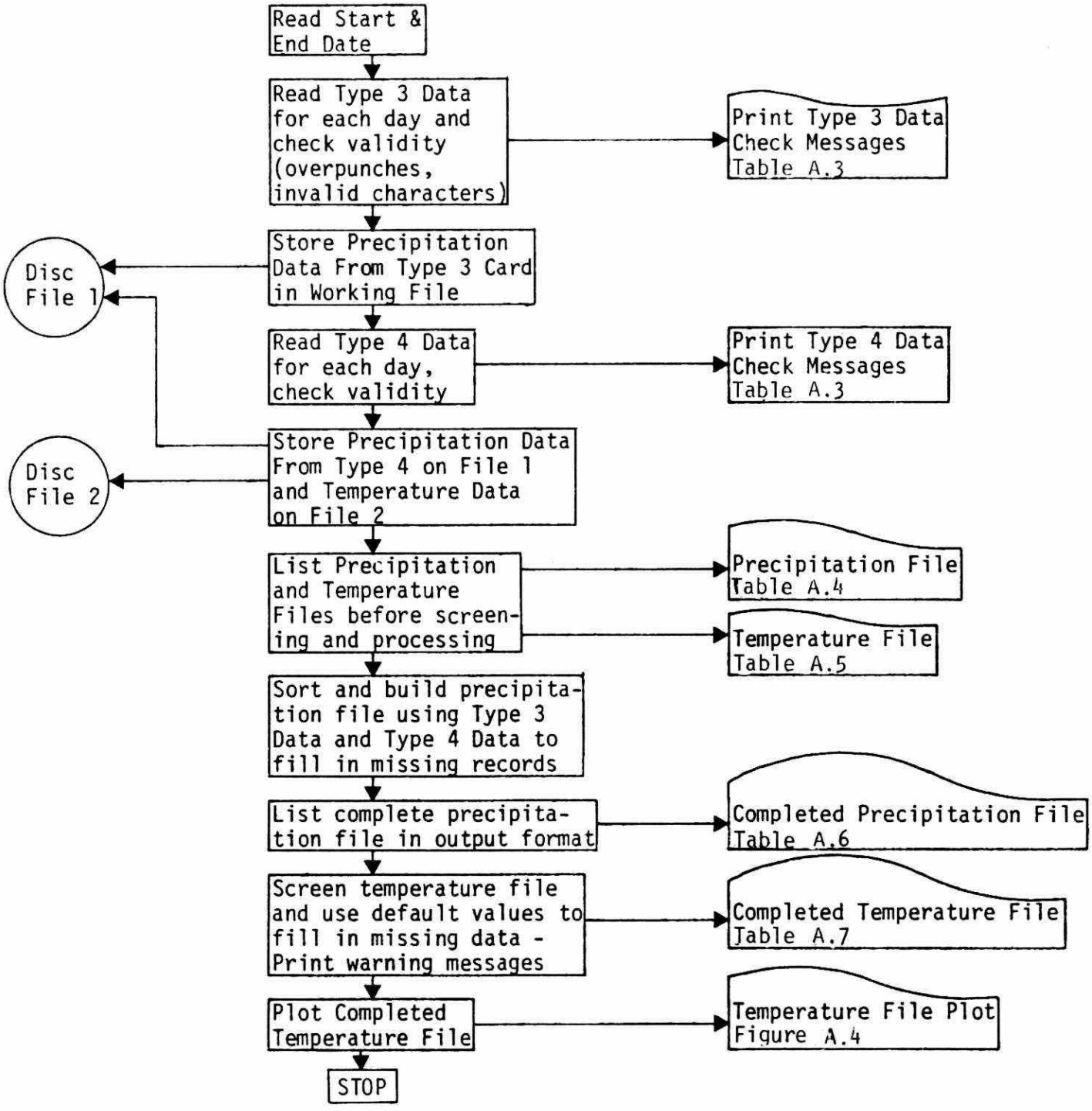

Read Start & End Date
Read Type 3 Data for each day and check validity (overpunches, invalid characters)
Print Type 3 Data Check Messages Table A.3
Disc File 1
Store Precipitation Data From Type 3 Card in Working File
Read Type 4 Data for each day, check validity
Print Type 4 Data Check Messages Table A.3
Disc File 2
Store Precipitation Data From Type 4 on File 1 and Temperature Data on File 2
List Precipitation and Temperature Files before screening and processing
Precipitation File Table A.4
Temperature File Table A.5
Sort and build precipitation file using Type 3 Data and Type 4 Data to fill in missing records
List complete precipitation file in output format
Completed Precipitation File Table A.6
Screen temperature file and use default values to fill in missing data - Print warning messages
Completed Temperature File Table A.7
Plot Completed Temperature File
Temperature File Plot Figure A.4
STOP

FIGURE A.2. DATA BANK PROCESSING

have not been processed the program automatically skips this procedure. Generally speaking, Type 4 data are used if winter precipitation and temperature records are required to model runoff due to snowmelt.

The details for data deck set-up and input variable formats are given in Figure A.3 and Table A.2, respectively.

A.5.4 Output

Tables A.3 to A.7 and Figure A.4 show typical output from the program and are referred to in Figure A.2.

Table A.3 shows the starting and ending dates for reading of raw data. Type 3 messages are occasioned by invalid characters or overpunches and the program assumes zero precipitation for these hours. A listing of the offending card is printed immediately following the warning for investigation by the user. Type 4 data messages follow next.

Table A.4 gives a listing of the contents of the Precipitation File containing both Type 3 and Type 4 data, before processing. On each printed line is the record number, six-figure date, code indicating which card type the data was taken from, and the precipitation data in hourly or six-hour totals, depending on the card type.

Table A.5 lists the contents of the temperature file made up of Type 4 data before screening and plotting.

Table A.6 shows the completed precipitation file after processing. Hourly values shown here are made up from the data shown in Table A.4.

Table A.7 shows the screening results from the temperature file. The pertinent control and screening values are shown at the top, followed by the file data and self-explanatory messages. Figure A.4 shows a plot of daily maximum and minimum temperatures from the screened file. The user should investigate any values which appear to be significantly "out of range" for the time of year and location.

The DBP processing may be performed for each of a number of stations, resulting in an output file of processed precipitation and temperature data for each station. This output is in a format for direct input to the Rainfall Analysis Program or the long-term simulator STORM, for modelling.

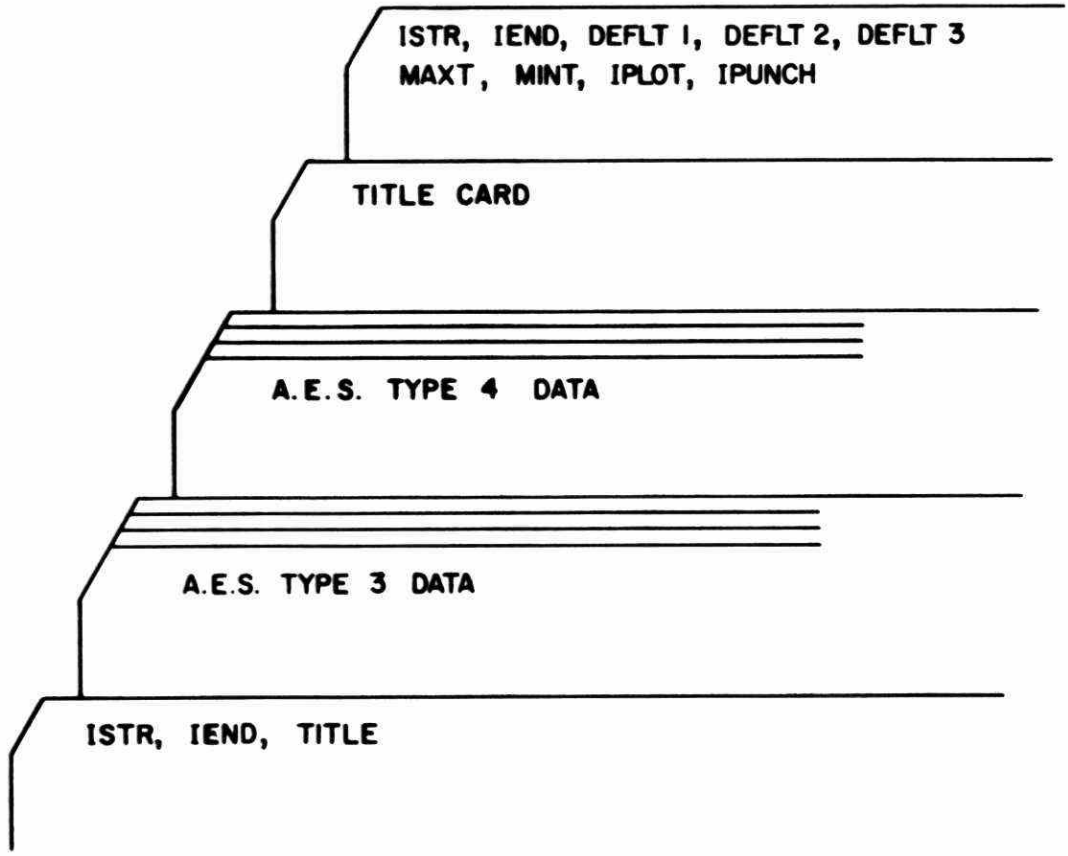


FIGURE A.3. DATA DECK FOR DATA BANK PROCESSING PROGRAM

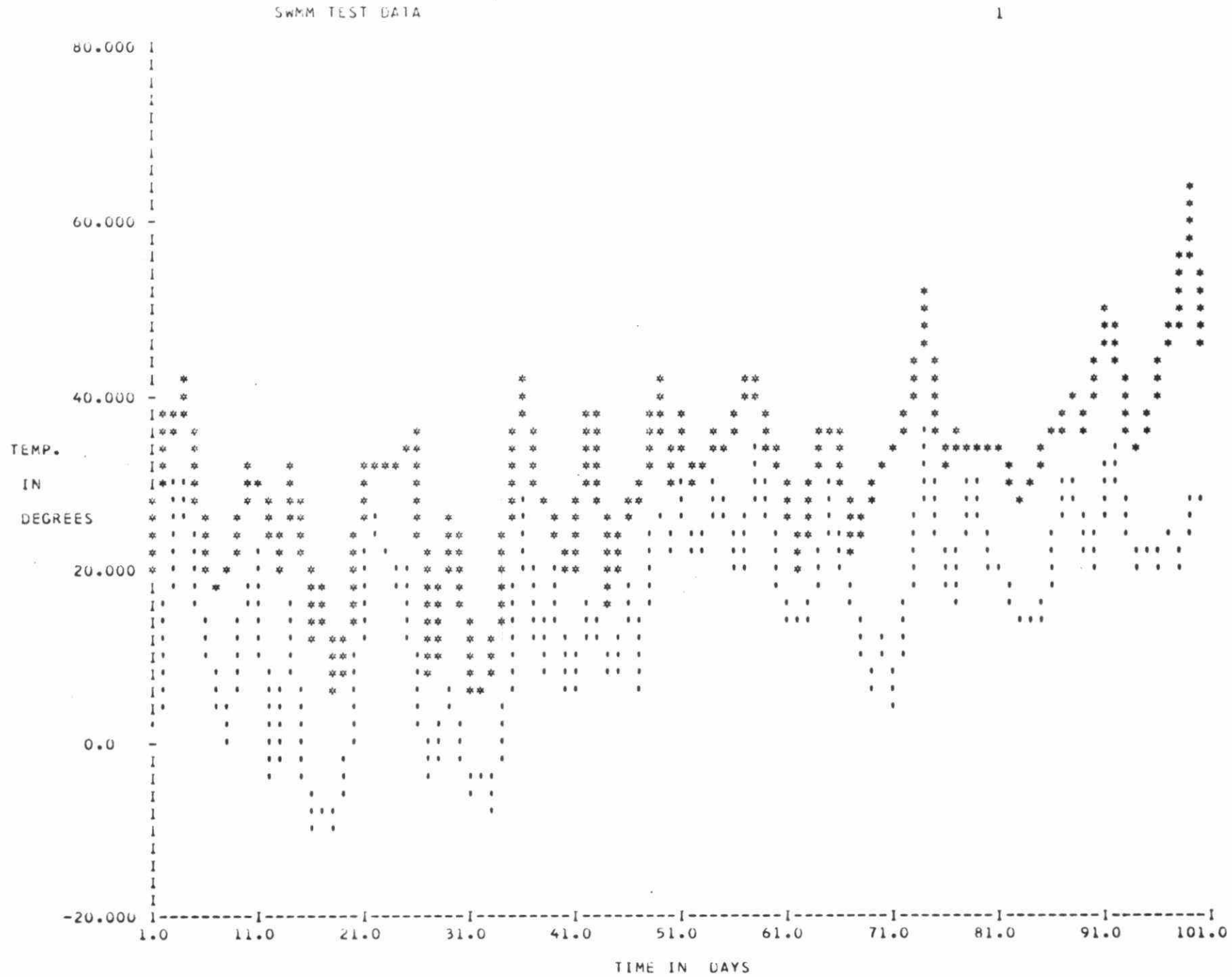


FIGURE A.4. TEMPERATURE PLOT

TABLE A.2. DATA BANK PROCESSING

Card Group	Format	Card Columns	Description	Variable Name	Default Value
1	2I6	1-6	Starting date of processing	ISTR	None
		7-12	Ending date of processing	IEND	None
	17A4	13-80	Title Card	TITLE	Blanks
2			Type 3 meteorological data on cards, tape or disk		
3			Type 4 meteorological data on cards, tape or disk		

NOTE: This portion of the program processes and stores valid information on disk between the dates specified. Of this information, all or part of it may receive further processing according to instructions in card group 5.

4	20A4	1-80	Title Card	TITL	Blanks
5	2I6	1-6	Starting date	ISTR	None
	7I3	7-12	Ending date	IEND	None
		13-15	Default maximum temperature (°F)	DEFLT1	50
		16-18	Default minimum temperature (°F)	DEFLT2	0
		19-21	Default average temperature (°F)	DEFLT3	32
		22-24	Warning maximum temperature	MAXT	50
		25-27	Warning minimum temperature	MINT	0
		28-31	To suppress temperature plot versus time enter any non-zero integer	IPLOT	0
		32-34	To suppress punched output in STORM format enter any non-zero integer	IPNCH	0

TABLE A.3. DATA CHECK MESSAGES

```
DATA BANK PROCESSING

STARTING DATE=  710101
ENDING DATE=    720101


TYPE 3 DATA CHECK MESSAGES


WARNING - FREEZING RAIN ASSUMED ZERO ON CARD
0361587647101131-                                  -  -  -  -
WARNING - FREEZING RAIN ASSUMED ZERO ON CARD
0361587647101132   -  -  -  -  -  -  -  -  -  -  -  -  -
WARNING - FREEZING RAIN ASSUMED ZERO ON CARD
0361587647101141   -  -  -  -  -  -  -  -
WARNING - FREEZING RAIN ASSUMED ZERO ON CARD
0361587647102041-                                  -  -  -  -
WARNING - FREEZING RAIN ASSUMED ZERO ON CARD
0361587647102042   -  -  -  -  -  -  -  -  -  -  -  -  -
WARNING - FREEZING RAIN ASSUMED ZERO ON CARD
0361587647102051   -  -  -  -  -  -  -  -  -    02    01 01
WARNING - FREEZING RAIN ASSUMED ZERO ON CARD
0361587647102221-                                  -  -  -  -
WARNING - FREEZING RAIN ASSUMED ZERO ON CARD
0361587647102222   -  -  -  -  -  -  -  -  -  -  -  -  -
WARNING - FREEZING RAIN ASSUMED ZERO ON CARD
0361587647102231   -  -  -  -  -  -  -  -
WARNING - FREEZING RAIN ASSUMED ZERO ON CARD
0361587647109191-                                  -  -  -  -
WARNING - FREEZING RAIN ASSUMED ZERO ON CARD
0361587647109192   -  -  -  -  -  -  -  -  -  -  -  -  -
WARNING - FREEZING RAIN ASSUMED ZERO ON CARD
0361587647109201   -  -  -  -  -  -  -  -     03 03 08
WARNING - FREEZING RAIN ASSUMED ZERO ON CARD
0361587647110031-                                  -  -  -  -
WARNING - FREEZING RAIN ASSUMED ZERO ON CARD
0361587647110032   -  -  -  -  -  -  -  -  -  -  -  -  -
WARNING - FREEZING RAIN ASSUMED ZERO ON CARD
0361587647110041   -  -  -  -  -  -  -  -


END OF TYPE 3 PROCESSING


TYPE 4 DATA CHECKING MESSAGES

MIN. TEMPERATURE IS AN ESTIMATE ON  720100
MAX. TEMPERATURE IS AN ESTIMATE ON  720100
INVALID TEMP. DATA ON  720100 .  DATA IGNORED
INVALID TEMP. DATA ON  720100 .  DATA IGNORED
INVALID TEMP. DATA ON  720100 .  DATA IGNORED
INVALID TEMP. DATA ON  720100 .  DATA IGNORED
INVALID DATA ON CARD
615865572010OTORONTO INT'L A          ONT YZ0578434107938E
DATA IGNORED                                                  L04
```

TABLE A.4. PRECIPITATION FILE

```
REC NO. 1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100  FEB 26/76
     1  7101041                                01 01 01 01
     2  7101042 02 03    01 01 01 02 03
     3  7101043 15 06 06000
     4  7101093000 01060 01
     5  7101113000 03 09000
     6  7101133000000 01000
     7  7101143 01000000000
     8  7101153000000000 01
     9  7101173000000000 02
    10  7101193 02000000 02
    11  7101213 06000 06000
    12  7101261                   02 01 01
    13  7101263 05000 05 10
    14  7101273 04000000000
    15  7101293000000 04 20
    16  7101303 03000000000
    17  7102013000000000 01
    18  7102033000 02000000
    19  7102043000000 08 18
    20  7102051                         02    01 01
    21  7102053 19 09000000
    22  7102073000000 03 05
    23  7102083 04 02 07 18
    24  7102093 04 01000000
    25  7102122    02 03 02 01 03 01
    26  7102123000000 14 15
    27  7102133 08000000000
    28  7102173000 16000000
    29  7102201       01 07 03       01 03 10 06 04
    30  7102202 01 01       01
    31  7102203 27 12000000
    32  7102213 01000000000
    33  7102223000000000 48
    34  7102233 28000000000
    35  7102261                         01
    36  7102262                               03
    37  7102263000000000 01
    38  7102271    08 01       01 01
    39  7102273 09000000000
    40  7103043 02000000000
    41  7103063000000000 24
    42  7103071       03 09 05
    43  7103073 20000000000
    44  7103103000000 05 07
    45  7103113 18 04000000
    46  7103153000 01000000
    47  7103163 01000000000
    48  7103193000 35 06 02
    49  7103203 02000000 01
    50  7103313000000000 04
    51  7104011 05
    52  7104012             05 05 04 08 07 04 01
    53  7104013 01000 10 15
    54  7104021          01
    55  7104023 01000000000
    56  7104031                              01
    57  7104033000000 01000
    58  7104131       03 06 05 01
    59  7104132          01       11 03 01 03
```

TABLE A.5. TEMPERATURE FILE

```
REC NO. 1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100  FEB 26/76
      1  710101620002
      2  710102036005
      3  710103035027
      4  710104042030
      5  710105032018
      6  710106019010
      7  710107017006
      8  710108019-01
      9  710109023009
     10  710110031018
     11  710111029021
     12  710112025-04
     13  710113019-02
     14  710114031015
     15  710115026000
     16  710116011-11
     17  710117017-09
     18  710118005-10
     19  710119006-04
     20  710120020001
     21  710121032019
     22  710122032025
     23  710123031022
     24  710124032018
     25  710125034019
     26  710126036004
     27  710127006-04
     28  710128012-01
     29  710129025006
     30  710130024000
     31  710131006-07
     32  710201005-05
     33  710202008-09
     34  710203020000
     35  710204031012
     36  710205042028
     37  710206029014
     38  710207028007
     39  710208026020
     40  710209020005
     41  710210019005
     42  710211037015
     43  710212037014
     44  710213016008
     45  710214022007
     46  710215028018
     47  710216028006
     48  710217035023
     49  710218041026
     50  710219030021
     51  710220037029
     52  710221030022
     53  710222031022
     54  710223035030
     55  710224033028
     56  710225036020
     57  710226042020
     58  710227042035
     59  710228034030
```

TABLE A.6. PROCESS RAINFALL INFORMATION

SWMM TEST DATA

PROCESSED RAINFALL INFORMATION

	DATE	HOURLY RAINFALL IN HUNDREDTHS OF INCHES																							
C	710104	3	5	3	2	2	2	1	1	1	1	1	1	2	3	0	1	1	1	2	3	0	0	0	0
C	710109	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
C	710111	0	0	0	0	0	0	1	1	1	0	0	0	2	2	2	1	1	1	0	0	0	0	0	0
C	710113	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
C	710114	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
C	710117	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
C	710119	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
C	710121	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
C	710126	1	1	1	0	0	2	1	1	0	0	0	0	1	1	1	1	1	0	2	2	2	2	1	1
C	710127	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710129	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	4	4	3	3	3	3
C	710130	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
C	710203	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710204	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	1	1	1	3	3	3	3	3	3
C	710205	4	3	3	3	3	3	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
C	710207	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	1	1	0
C	710208	1	1	1	1	0	0	1	1	0	0	0	0	2	1	1	1	1	1	3	3	3	3	3	3
C	710209	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710212	0	0	0	0	0	0	0	0	0	0	0	0	3	2	3	2	1	3	1	3	3	3	3	2
C	710213	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710217	0	0	0	0	0	0	3	3	3	3	2	2	0	0	0	0	0	0	0	0	0	0	0	0
C	710220	6	5	1	7	3	5	0	1	3	10	6	4	1	1	0	0	1	0	0	0	0	0	0	0
C	710221	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710222	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8	8	8	8	8
C	710223	5	5	5	5	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710226	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
C	710227	0	8	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710304	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710306	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	4
C	710307	1	1	3	9	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710310	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	2	1	1	1	1	1
C	710311	3	3	3	3	3	3	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710315	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710316	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710319	0	0	0	0	0	0	6	6	6	6	6	5	1	1	1	1	1	1	1	1	0	0	0	0
C	710320	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
C	710331	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0
C	710401	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	4	8	7	4	1	0
C	710402	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710403	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
C	710413	2	2	3	8	5	1	0	0	0	0	0	0	3	2	2	1	2	2	11	3	1	3	0	0
C	710424	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710425	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710426	0	1	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710428	0	0	0	0	0	0	0	1	8	3	0	0	1	0	0	0	2	2	0	4	9	1	1	0
C	710430	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
C	710501	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	4	1	0	3	1	0	1	0
C	710502	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	3	1
C	710503	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	710508	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
C	710512	0	0	0	0	0	0	1	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0

TABLE A.7. TEMPERATURE PROCESSING

```
SAMN TEST DATA
 STARTING DATE=  710101
 ENDING DATE=  720101
 DEFAULT MAX TEMP.=     0
 DEFAULT MIN TEMP.=     0
 DEFAULT AVG TEMP.=     0
 WARNING FOR TEMP. ABOVE   50
 WARNING FOR TEMP. LESS THAN     0
 PLOT=     0
```

D	710101	20	2	
D	710102	38	5	
D	710103	35	29	
D	710104	42	30	
D	710105	32	18	
D	710106	19	10	
D	710107	17	6	
D	710108	19	-1	MINIMUM TEMP. OF -1 EXCEEDS RANGE SPECIFIED
D	710109	23	9	
D	710110	31	18	
D	710111	29	21	
D	710112	25	-4	MINIMUM TEMP. OF -4 EXCEEDS RANGE SPECIFIED
D	710113	19	-2	MINIMUM TEMP. OF -2 EXCEEDS RANGE SPECIFIED
D	710114	31	15	
D	710115	28	0	
D	710116	11	-11	MINIMUM TEMP. OF -11 EXCEEDS RANGE SPECIFIED
D	710117	17	-9	MINIMUM TEMP. OF -9 EXCEEDS RANGE SPECIFIED
D	710118	5	-10	MINIMUM TEMP. OF -10 EXCEEDS RANGE SPECIFIED
D	710119	8	-4	MINIMUM TEMP. OF -4 EXCEEDS RANGE SPECIFIED
D	710120	20	1	
D	710121	32	19	
D	710122	32	25	
D	710123	31	22	
D	710124	32	16	
D	710125	34	19	
D	710126	36	4	
D	710127	8	-4	MINIMUM TEMP. OF -4 EXCEEDS RANGE SPECIFIED
D	710128	12	-1	MINIMUM TEMP. OF -1 EXCEEDS RANGE SPECIFIED
D	710129	25	6	
D	710130	24	0	
D	710131	6	-7	MINIMUM TEMP. OF -7 EXCEEDS RANGE SPECIFIED
D	710201	5	-5	MINIMUM TEMP. OF -5 EXCEEDS RANGE SPECIFIED
D	710202	8	-9	MINIMUM TEMP. OF -9 EXCEEDS RANGE SPECIFIED
D	710203	20	0	
D	710204	31	12	
D	710205	42	28	
D	710206	29	14	
D	710207	25	7	
D	710208	26	20	
D	710209	20	5	
D	710210	19	5	
D	710211	37	15	
D	710212	37	14	
D	710213	16	8	
D	710214	22	7	

A.6 Rainfall Analysis Program (RAP)

The Rainfall Analysis Program was developed to accept as input the processed precipitation records of various gauging stations and to combine these records into a single record according to input weighting factors. It will further summarize all storms in the synthesized record, and produce mass analysis and double mass analysis plots of the input gauge records.

A.6.1 Input and processing

Figure A.5 shows the functional flow chart for this program. The program first reads in a title card for the job, then the number of gauge records to be input and the year are read. At the same time, weighting factors for each gauge are read. These factors may be in any units, and the user may compute them using distance to centroids, Theissen polygon method, Normal Ratio method, or any other desired method.

The program combines the rainfall records of each gauge using the following formula:

$$P = \frac{P_1 X_1 + P_2 X_2 + \ldots + P_n X_n}{\sum_{i=1}^{n} X_i}$$

where: P is the combined precipitation,

$P_i \ldots P_n$ are the individual gauge precipitations,

$X_i \ldots X_n$ are the weighting factors for each gauge.

Control variables for punched output, storm summaries and storm definitions are next read in. The program then reads in the gauges for which double mass analysis is required. These gauge numbers refer to the order in which they will be read in.

The final input is a gauge title card, and the complete rainfall record for each gauge. The program processes information in periods of up to one full calendar year at a time, and then repeats the analysis for subsequent years of data if required.

The details for data deck set-up and input variable formats are given in Figure A.6 and Table A.8, respectively.

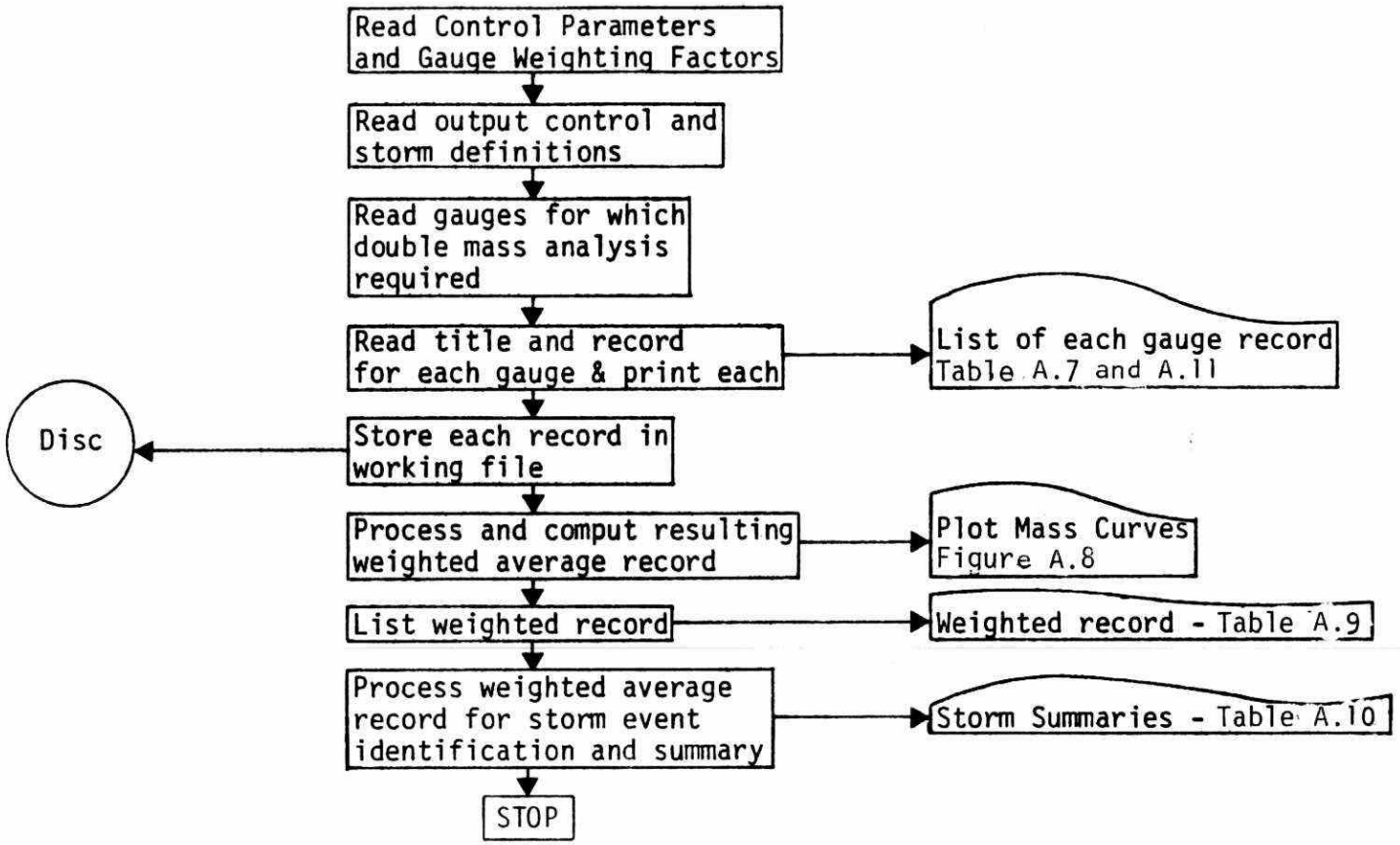

Read Control Parameters and Gauge Weighting Factors
Read output control and storm definitions
Read gauges for which double mass analysis required
Read title and record for each gauge & print each
List of each gauge record Table A.7 and A.11
Disc
Store each record in working file
Process and comput resulting weighted average record
Plot Mass Curves Figure A.8
List weighted record
Weighted record - Table A.9
Process weighted average record for storm event identification and summary
Storm Summaries - Table A.10
STOP

FIGURE A.5. RAINFALL ANALYSIS

A.6.2 Output

Tables A.9 and A.10 show the printout of control information for processing and output, and list the input gauge records. In this case, two gauges have been read in.

Figure A.7 shows the mass analysis of both gauges. If five gauges had been used, this plot would represent the mass curve for one gauge versus the average for the four other gauges.

Table A.11 shows the resulting weighted average precipitation record.

Table A.12 is part of the storm summary for the study area. Each storm event is identified according to the printed definition, and information on timing, antecedent conditions, duration, and rainfall of each is printed. This summary may be useful in identifying critical events in a long record without even proceeding with long-term simulation.

A.6.3 Other uses of the Rainfall Analysis Program

The Rainfall Analysis Program may be used to obtain a storm summary and a plot of the precipitation mass curve, for a given gauging station simply by setting the weighting factors of all other gauges to zero.

The program may also be used to reduce or increase the rainfall records of any gauging station by supplying a second gauging station with no rainfall record, but having a weighting factor other than zero. This feature may be desirable to account for altitude or other physical differences between a given study area and the gauging station to which the correction is applied.

A.7 Short Interval Rain Data Processing

Detailed simulation using the SWMM model requires short interval (five minutes or less) rainfall data as input. Data in this detailed form are available only from the individual rain gauge strip charts stored in the AES archives. These data have not been digitized or keypunched as have the hourly data. For a single storm simulation, manual preparation of this rainfall data is most efficient. However, when simu-

lating numerous storm events, such as in the case of a lumped SWMM study, the work involved in handing these data may be quite arduous.

The Short Interval Rain Data Processing program has been developed to accept digitized rainfall records in any units of rainfall amount and time, and to compute the weighted average of several gauges, as well as punching the resulting hyetograph in any specified time interval. Factors are read in to convert the data to absolute values. For example, with a gauge sensing 30 hundredths of an inch of precipitation in a five-minute interval, the input may be 30 and a factor of 0.01 used. The punched output is in a format for direct input into SWMM.

A.7.1 Input and processing

Figure A.8 shows the functional flow chart for this program. The program first reads in a title card, then the time interval for the input values and for the desired output. At the same time, the conversion factor for rainfall, output control, and the number of gauges is also read.

The weighting factor, in the same sense as for the hourly data, and the rainfall information for each gauge is read in. For a recording tipping bucket rain gauge, which places a data point on the chart for each tip, the input information may be the number of data per five-minute chart division and the bucket volume becomes the rainfall factor.

The details for data deck set-up and input variable formats are given in Figure A.9 and Table A.13, respectively.

A.7.2 Output

Tables A.14 to A.16 show the output from this program for a typical storm event. Control information is printed followed by a listing of the input values.

The cumulative rainfall amounts are computed and printed, and the output hyetograph in inches per hour is printed for each of two gauges. The combined weighted hyetograph is listed last, and may be punched in SWMM format.

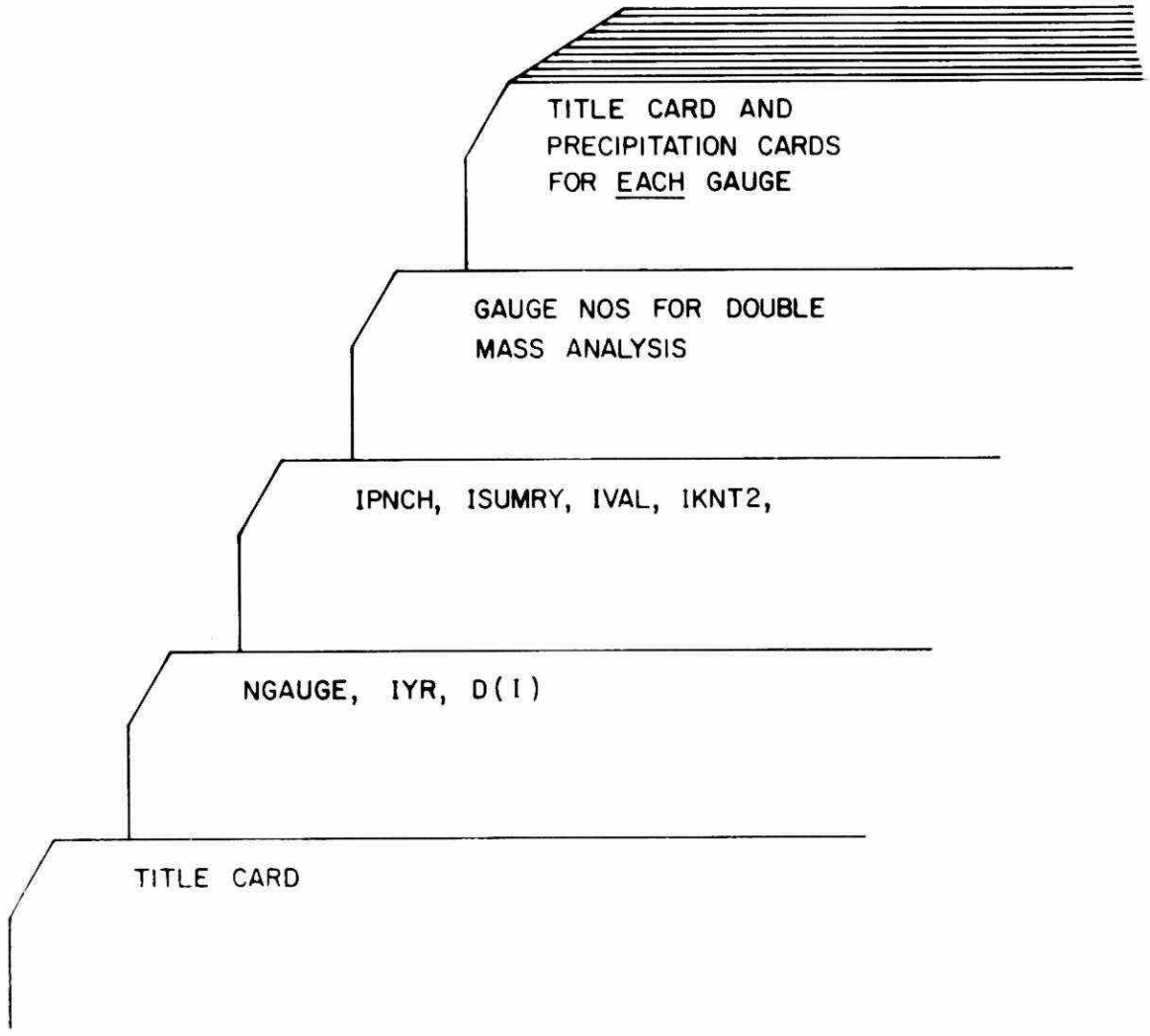


FIGURE A.6. DATA DECK FOR RAINFALL ANALYSIS PROGRAM

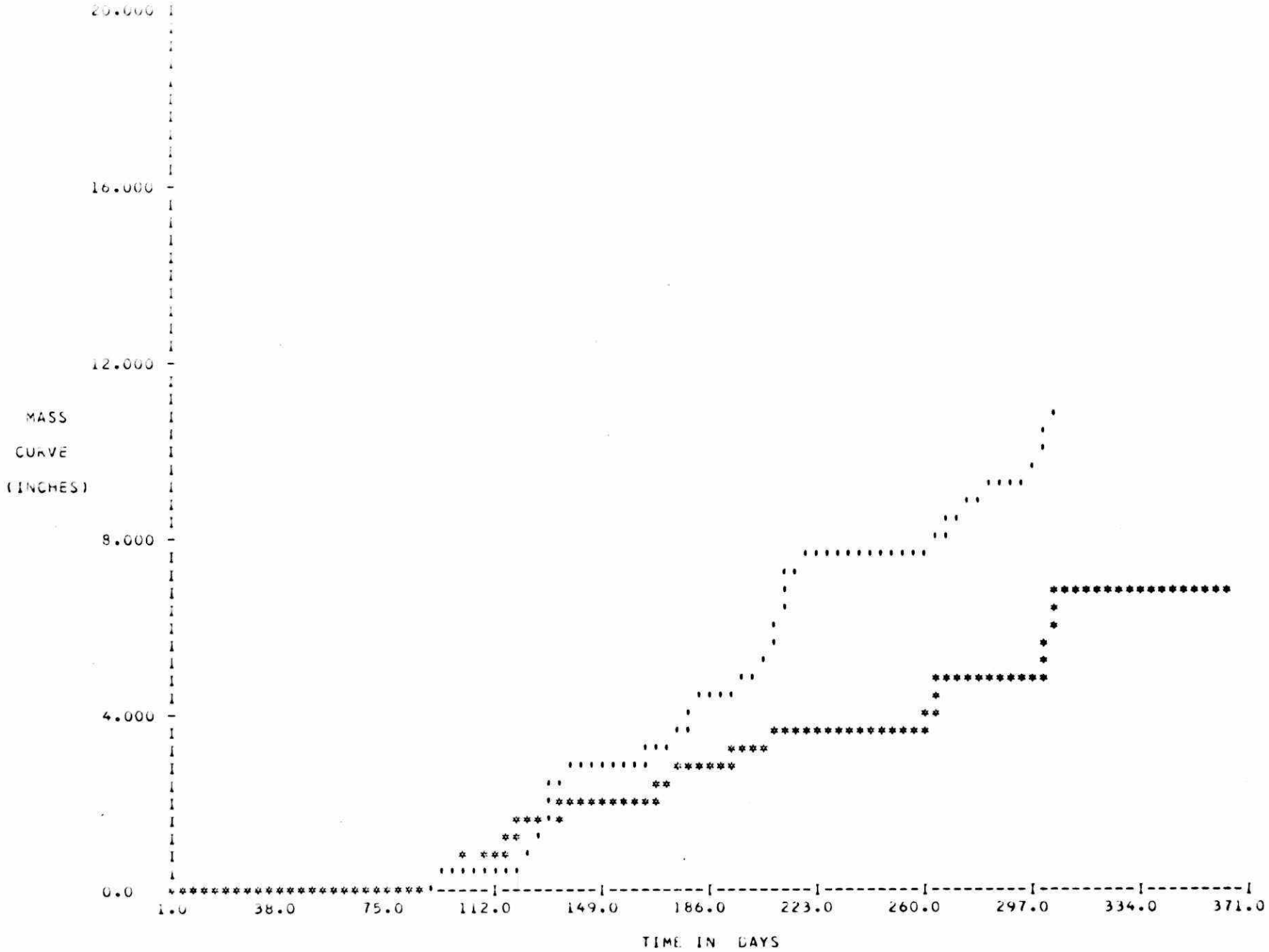


FIGURE A.7. MASS CURVE PLOT

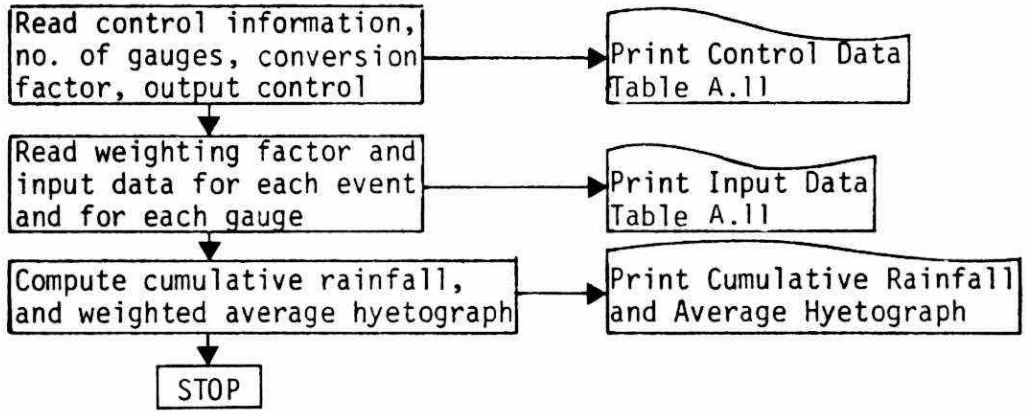

Read control information, no. of gauges, conversion factor, output control
Print Control Data Table A.11
Read weighting factor and input data for each event and for each gauge
Print Input Data Table A.11
Compute cumulative rainfall, and weighted average hyetograph
Print Cumulative Rainfall and Average Hyetograph
STOP

FIGURE A.8. SHORT INTERVAL RAIN DATA PROCESSING CHART

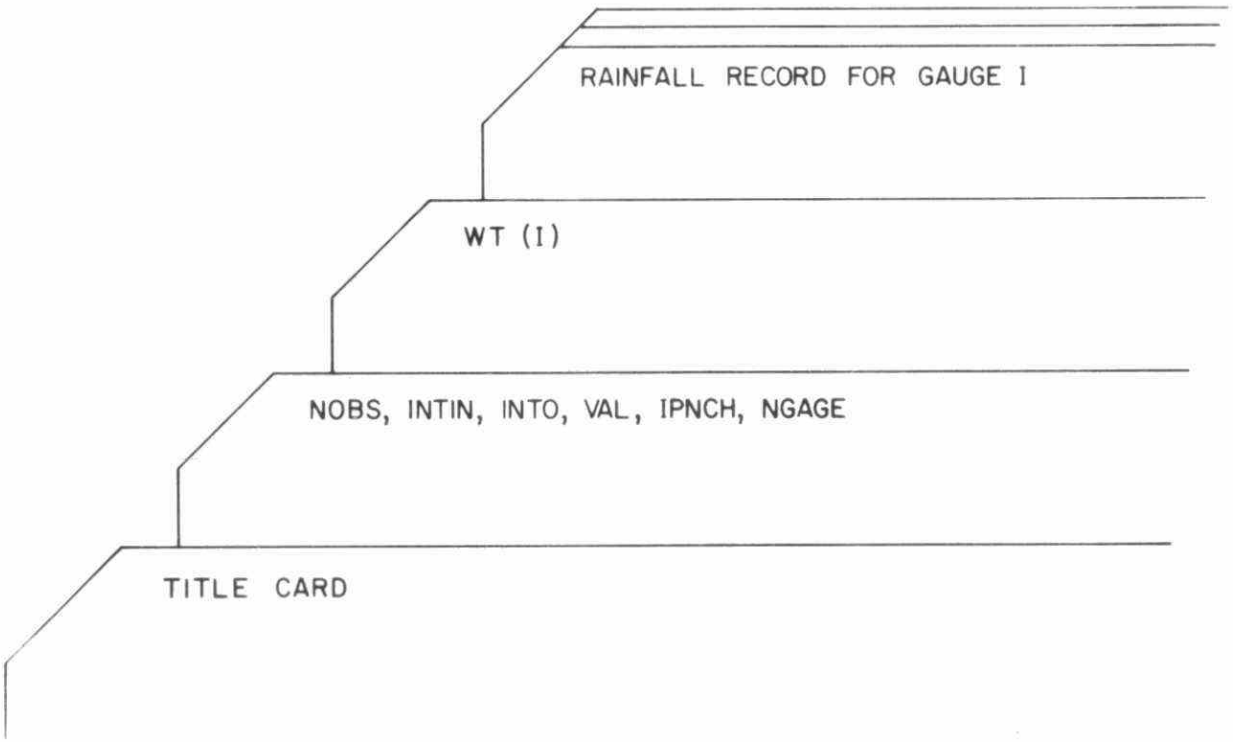


FIGURE A.9. DATA DECK FOR SHORT INTERVAL RAIN DATA PROCESSING PROGRAM

TABLE A.8. RAINFALL ANALYSIS PROGRAM

Card Group	Format	Card Columns	Description	Variable Name	Default Value
1	20A4	1-80	Title Card	TITL	Blanks
2	4I4, 6F8.0	1-4	No. of gauges to be combined	NGAUGE	None
		5-8	Year to be processed	IYR	0
		9-16	Weighting from gauge no. 1	D(1)	0
		16-24	Weighting from gauge no. 2	D(2)	0
		.	.	.	.
		.	.	.	.
		.	.	.	.
3	4I4	1-4	If punched output required entry any non-zero integer	IPNCH	0
		5-8	If storm summary required enter any non-zero integer	ISUMRY	0
		9-12	Total inches of rainfall which defines a storm	IVAL	1
		13-16	No. of consecutive dry hours which terminate a storm	IKNT2	1
4	6I5	1-5	If double mass analysis required for gauge no. 1 enter any non-zero value	IPLOTG(1)	0
		6-10	If double mass analysis required for gauge no. 2 enter any non-zero value	IPLOTG(2)	0
		.	.	.	.
		.	.	.	.
		.	.	.	.
5	20A4		Gauge title card		Blanks
6	8X,24I3	9-11 12-14 . . .	Hourly rainfall data in STORM Format, one card per day ended by one blank card		None

NOTE: Card groups 5 and 6 should be repeated for each gauge in the order specified in card group 2.

TABLE A.8. (CONT'D)

Card Group	Format	Card Columns	Description	Variable Name	Default Value
NOTE: Include card groups 7 and 8 only if subsequent years of card group 6 data are to be analyzed using the control information given in card groups 1 to 5.					
7	I4	1-4	Year to be processed	IYR	0
8			Repeat card group 5 and 6 for each gauge for year given in card group 7		None
NOTE: Repeat card group 7 and 8 as often as required					

TABLE A.9. RAINFALL ANALYSIS CONTROL DATA

RAINFALL ANALYSIS PROGRAM
****

SWMM - WEST TORONTO STUDY AREA

GAUGE NO.	WEIGHTING
1	2.0
2	3.0

PUNCH= 0
SUMMARY= 1
DOUBLE MASS CURVE REQUESTED FOR GAUGES 1 0 0 0 0 0

GAUGE NUMBER 1

GAUGE WITHIN STUDY AREA NO. 2502

730401	0	0	0	0	0	0	0	0	0	5	1	0	2	0	0	1	0	0	0	0	0	0	0	0
730403	2	3	3	2	3	2	2	0	0	2	0	1	0	1	1	0	1	0	1	0	0	0	1	0
730405	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
730416	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	
730422	0	0	0	0	0	0	0	0	0	1	6	0	3	0	0	0	0	0	0	0	0	0	0	0
730428	2	0	1	2	0	0	0	0	0	0	0	2	0	1	0	0	1	0	0	0	0	0	0	0
730502	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	16	0	0	0	0
730508	0	0	1	1	0	0	1	0	0	0	1	13	12	3	1	3	0	6	7	1	0	11	2	0
730510	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	65	0	17	6	11	0
730512	4	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
730516	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	6	3	0	0	0
730521	2	1	4	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
730601	0	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
730605	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7
730607	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
730612	0	0	0	0	0	0	0	0	0	0	4	2	2	3	0	0	0	0	0	0	0	0	0	0
730617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
730622	0	0	0	0	0	0	0	0	0	0	0	0	4	33	0	0	0	0	0	0	0	0	0	0
730626	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
730628	2	2	0	0	1	0	0	0	0	0	0	0	0	1	0	58	10	1	0	0	0	0	0	0
730704	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	8	0	0	0	0	0	0
730713	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0
730725	0	0	0	15	22	36	0	7	3	1	0	0	0	0	0	0	3	0	5	0	0	0	0	0
730727	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	3	2	0	0	0	0	0	0
730801	78	78	11	10	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
730810	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	12	0	0	0	5	0	0	0
730820	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	1	0	0	0	0
730918	0	7	0	1	1	*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
730923	0	0	0	0	0	0	0	0	14	17	6	0	0	3	0	0	0	0	0	0	0	0	0	0
731002	0	2	2	3	10	8	0	1	0	0	0	0	0	0	0	0	0	0	0	9	31	4	0	1
731013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	13	4	1	2	0	0	2	0
731017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
731019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	5	2	0	0	0	0	0	0
731028	0	1	1	1	0	1	1	1	0	0	0	0	0	1	4	1	4	9	12	17	14	11	4	1
731030	0	15	2	0	0	3	4	0	2	2	4	6	7	3	4	4	1	1	5	2	2	0	0	0

TABLE A.10. RAINFALL DATA

GAUGE NUMBER 2

GAUGE OUTSIDE STUDY AREA NO. 2906

730402	0	1	0	0	1	0	1	1	0	2	4	1	1	4	1	2	5	2	1	1	1	1	0	0
730404	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	5	4	3	1	2	2	1
730410	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0
730419	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
730427	0	0	0	0	0	0	0	0	0	1	3	1	3	4	3	4	2	7	6	8	4	12	14	5
730501	0	1	0	0	0	0	0	0	10	11	3	0	1	0	0	0	0	1	0	0	0	0	0	0
730504	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1
730509	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
730511	0	0	0	0	1	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
730515	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
730520	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
730531	3	3	1	1	9	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
730603	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
730606	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
730609	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
730616	0	0	0	0	0	0	2	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
730618	2	22	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
730624	0	0	0	0	7	7	6	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
730627	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4	1
730701	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
730712	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
730714	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
730726	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	13	0	0	0
730728	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	6	0	0	0	0	0	0	0
730802	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
730811	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
730917	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	7	2	0	0	12	9
730922	0	0	8	11	1	0	15	25	3	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0
731001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
731004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0
731016	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
731018	0	0	0	2	2	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
731027	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
731029	0	0	0	14	8	6	4	2	0	0	0	1	4	7	7	7	8	11	22	18	7	1	7	2
731031	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	4	7	4	9	5	7

TABLE A.11. WEIGHTED PRECIPITATION

SWMM - WEST TORONTO STUDY AREA

RESULTING RAINFALL INFORMATION FOR STUDY AREA

C	730401	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0
C	730402	0	1	0	0	1	0	1	1	0	1	2	1	1	2	1	1	3	1	1	1	1	1	0	0
C	730403	1	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730404	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	2	2	1	1	1	1
C	730405	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730410	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
C	730416	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
C	730419	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730422	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0
C	730427	0	0	0	0	0	0	0	0	0	1	2	1	2	2	2	2	1	4	4	5	2	7	8	3
C	730428	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
C	730501	0	1	0	0	0	0	0	0	6	7	2	0	1	0	0	0	0	1	0	0	0	0	0	0
C	730502	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730504	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1
C	730508	0	0	0	0	0	0	0	0	0	0	0	5	5	1	0	1	0	2	3	0	0	4	1	0
C	730509	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
C	730510	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0	7	2	4	0
C	730511	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730512	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730515	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730516	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0
C	730520	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
C	730521	1	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730531	2	2	1	1	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
C	730601	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730603	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
C	730605	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
C	730606	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
C	730607	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730609	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730612	0	0	0	0	0	0	0	0	0	0	2	1	1	1	0	0	0	0	0	0	0	0	0	0
C	730616	0	0	0	0	0	0	1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730618	1	13	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730622	0	0	0	0	0	0	0	0	0	0	0	0	2	13	0	0	0	0	0	0	0	0	0	0
C	730624	0	0	0	0	4	4	4	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730626	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
C	730627	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	1	
C	730628	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	23	4	0	0	0	0	0	0	0
C	730701	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730704	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0
C	730712	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
C	730713	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0
C	730714	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730725	0	0	0	6	9	14	0	3	1	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0
C	730726	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	8	0	0
C	730727	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	1	0	0	0	0	0	0
C	730728	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
C	730801	31	31	4	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	730802	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
C	730810	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	5	0	0	0	2	0	0	0

TABLE A.12. STORM SUMMARY

A STORM HAS BEEN DEFINED AS HAVING A TOTAL RAINFALL (IN HUNDREDTHS OF INCHES) GREATER THAN .5 AND HAVING LESS THAN .5 CONSECUTIVE DRY HOURS.

SWMM - WEST TORONTO STUDY AREA

STORM NUMBER 1

STARTED ON THE 4 MTH, 2 DAY, 2 HOUR
ANTECEDENT DRY DAYS UNKNOWN
ENDED ON THE 4 MTH, 3 DAY, 10 HOUR
TOTAL DURATION IN HOURS= 33
TOTAL RAINFALL IN HUNDREDTHS OF INCHES= 29
MAXIMUM INTENSITY IN HUNDREDTHS OF INCHES PER HOUR= 3

STORM NUMBER 2

STARTED ON THE 4 MTH, 4 DAY, 16 HOUR
ANTECEDENT DRY DAYS= 1.208
ENDED ON THE 4 MTH, 4 DAY, 24 HOUR
TOTAL DURATION IN HOURS= 9
TOTAL RAINFALL IN HUNDREDTHS OF INCHES= 14
MAXIMUM INTENSITY IN HUNDREDTHS OF INCHES PER HOUR= 3

STORM NUMBER 3

STARTED ON THE 4 MTH, 27 DAY, 10 HOUR
ANTECEDENT DRY DAYS= 22.375
ENDED ON THE 4 MTH, 28 DAY, 4 HOUR
TOTAL DURATION IN HOURS= 19
TOTAL RAINFALL IN HUNDREDTHS OF INCHES= 48
MAXIMUM INTENSITY IN HUNDREDTHS OF INCHES PER HOUR= 8

STORM NUMBER 4

STARTED ON THE 5 MTH, 1 DAY, 9 HOUR
ANTECEDENT DRY DAYS= 3.167
ENDED ON THE 5 MTH, 1 DAY, 13 HOUR
TOTAL DURATION IN HOURS= 5
TOTAL RAINFALL IN HUNDREDTHS OF INCHES= 16
MAXIMUM INTENSITY IN HUNDREDTHS OF INCHES PER HOUR= 7

STORM NUMBER 5

STARTED ON THE 5 MTH, 2 DAY, 21 HOUR
ANTECEDENT DRY DAYS= 1.292
ENDED ON THE 5 MTH, 2 DAY, 21 HOUR
TOTAL DURATION IN HOURS= 1
TOTAL RAINFALL IN HUNDREDTHS OF INCHES= 6
MAXIMUM INTENSITY IN HUNDREDTHS OF INCHES PER HOUR= 6

TABLE A.13. SHORT INTERVAL RAIN DATA PROCESSING CARD DATA

Card Group	Format	Card Columns	Description	Variable Name	Default Value
1	80A1	1-80	Title Card	TITLE	Blanks
2	3I5	1-5	No. of rainfall observations	NOBS	None
		6-10	Time interval of input rainfall (minutes)	INTIN	None
		11-15	Time interval of output rainfall (minutes)	INTO	None
	F5.1	16-20	Conversion factor from given rainfall units to inches	VAL	None
	2I5	21-25	If punched output in SWMM format required enter any non-zero integer	IPNCH	0
		26-30	No. of gauges to be combined	NGAGE	None
NOTE:	The number of observations and the time interval between values must be the same for all gauges to be combined.				
3	F10.2	1-10	Weighting factor for gauge 1	WT(1)	1.0
4	10F5.2	1-5	Rainfall information for first time period for gauge no. 1	HYET1(1)	0.0
		6-10	Rainfall information for second time interval for gauge no. 1	HYET1(2)	0.0
		.	.		
		.	.		
		.	.		
NOTE:	As many cards as required may be used in card group 4. Card groups 3 and 4 should be repeated for each gauge as specified in card group 2.				

TABLE A.14. SHORT INTERVAL RAIN DATA PROCESSING PROGRAM CONTROL DATA

```
SWMM - WEST TORONTO STUDY AREA  - STORM OF MAY 10,1973.

NO. OF INPUT POINTS=   13
INPUT TIME INTERVAL IN MINUTES=    5
OUTPUT TIME INTERVAL IN MINUTES=   2
RAINFALL CONVERSION FACTOR TO INCHES=   0.010
NO. OF GAGES =    2
PUNCHED OUTPUT NOT REQUIRED



GAUGE NO.    1      WEIGHT =    1.00


INPUT RAINFALL                              IN    5 MINUTE INTERVALS

 3.000  3.000  9.000  2.000  4.000  2.000  8.000 10.000 19.000  2.000
 2.000  1.000  0.0


INPUT RAINFALL IN INCHES                    IN    5 MINUTE INTERVALS

 0.030  0.030  0.090  0.020  0.040  0.020  0.080  0.100  0.190  0.020
 0.020  0.010  0.0


INPUT CUMULATIVE RAINFALL IN INCHES     IN    5 MINUTE INTERVALS

 0.030  0.060  0.150  0.170  0.210  0.230  0.310  0.410  0.600  0.620
 0.640  0.650  0.650


OUTPUT CUMULATIVE RAINFALL IN INCHES    IN    2 MINUTE INTERVALS

 0.012  0.024  0.036  0.048  0.060  0.096  0.132  0.154  0.162  0.170
 0.186  0.202  0.214  0.222  0.230  0.262  0.294  0.330  0.370  0.410
 0.486  0.562  0.604  0.612  0.620  0.628  0.636  0.642  0.646  0.650
 0.650  0.650  0.650


OUTPUT RAINFALL IN INCHES               IN    2 MINUTE INTERVALS

 0.012  0.012  0.012  0.012  0.012  0.036  0.036  0.022  0.008  0.008
 0.016  0.016  0.012  0.008  0.008  0.032  0.032  0.036  0.040  0.040
 0.076  0.076  0.042  0.008  0.008  0.008  0.008  0.006  0.004  0.004
 0.0    0.0    0.0


OUTPUT RAINFALL IN INCHES/HR.           IN    2 MINUTE INTERVALS

 0.360  0.360  0.360  0.360  0.360  1.080  1.080  0.660  0.240  0.240
 0.480  0.480  0.360  0.240  0.240  0.960  0.960  1.080  1.200  1.200
 2.280  2.280  1.260  0.240  0.240  0.240  0.240  0.180  0.120  0.120
 0.0    0.0    0.0
```

TABLE A.15. RAINFALL CONVERSION

GAUGE NO. 2 WEIGHT = 1.00

INPUT RAINFALL IN 5 MINUTE INTERVALS

2.000 2.000 5.000 1.000 3.000 4.000 6.000 8.000 15.000 5.000
2.000 1.000 0.0

INPUT RAINFALL IN INCHES IN 5 MINUTE INTERVALS

0.020 0.020 0.050 0.010 0.030 0.040 0.060 0.080 0.150 0.050
0.020 0.010 0.0

INPUT CUMULATIVE RAINFALL IN INCHES IN 5 MINUTE INTERVALS

0.020 0.040 0.090 0.100 0.130 0.170 0.230 0.310 0.460 0.510
0.530 0.540 0.540

OUTPUT CUMULATIVE RAINFALL IN INCHES IN 2 MINUTE INTERVALS

0.008 0.016 0.024 0.032 0.040 0.060 0.080 0.092 0.096 0.100
0.112 0.124 0.138 0.154 0.170 0.194 0.218 0.246 0.278 0.310
0.370 0.430 0.470 0.490 0.510 0.518 0.526 0.532 0.536 0.540
0.540 0.540 0.540

OUTPUT RAINFALL IN INCHES IN 2 MINUTE INTERVALS

0.008 0.008 0.006 0.008 0.008 0.020 0.020 0.012 0.004 0.004
0.012 0.012 0.014 0.016 0.016 0.024 0.024 0.028 0.032 0.032
0.060 0.060 0.040 0.020 0.020 0.008 0.008 0.006 0.004 0.004
0.0 0.0 0.0

OUTPUT RAINFALL IN INCHES/HR. IN 2 MINUTE INTERVALS

0.240 0.240 0.240 0.240 0.240 0.600 0.600 0.360 0.120 0.120
0.360 0.360 0.420 0.480 0.480 0.720 0.720 0.840 0.960 0.960
1.800 1.800 1.200 0.600 0.600 0.240 0.240 0.180 0.120 0.120
0.0 0.0 0.0

TABLE A.16. COMBINED RAINFALL

COMBINED RAINFALL IN INCHES/HR. IN 2 MINUTE INTERVALS

0.300	0.300	0.300	0.300	0.300	0.840	0.840	0.510	0.180	0.180
0.420	0.420	0.390	0.360	0.360	0.840	0.840	0.960	1.080	1.080
2.040	2.040	1.230	0.420	0.420	0.240	0.240	0.180	0.120	0.120
0.0	0.0	0.0							

APPENDIX B

ATMOSPHERIC ENVIRONMENT SERVICE

Card Type 3 and
Card Type 4 Formats

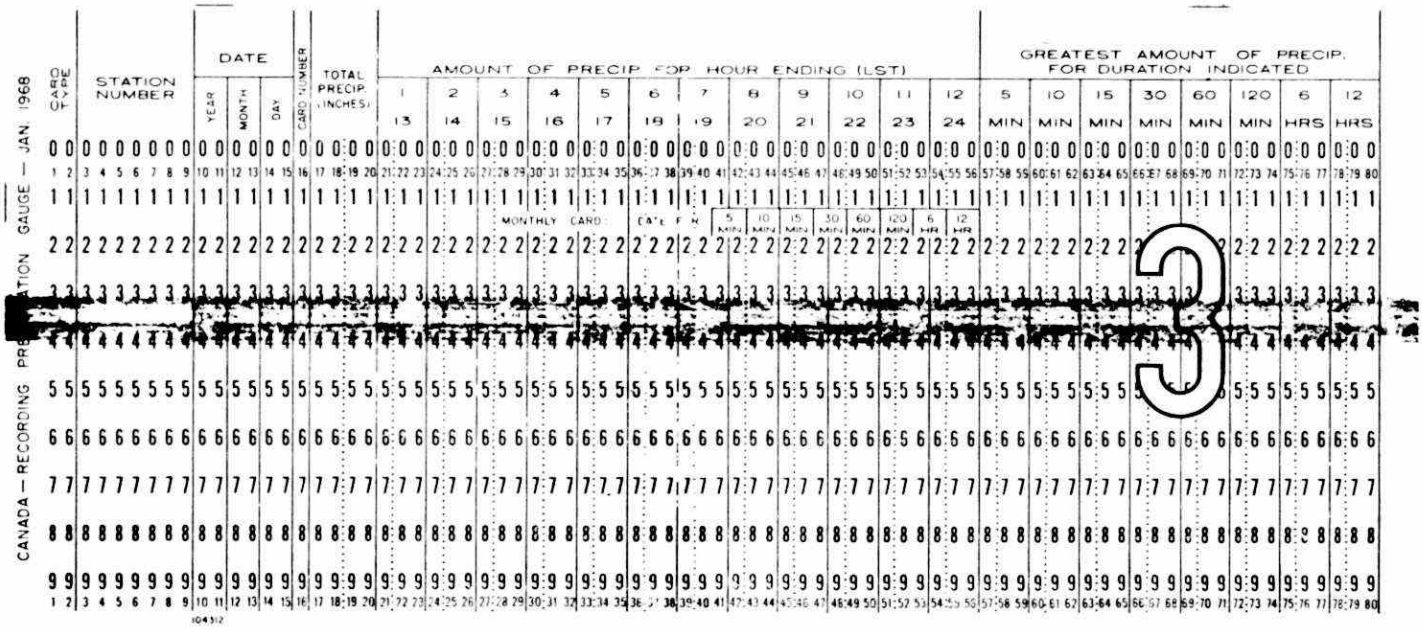
GENERAL

RECORDING PRECIPITATION GAUGE DATA: This card format was prepared for use with punched cards produced from recordings of the MSC tipping bucket rain gauge commencing 1960. Punched for 106 stations beginning in 1960 and now increased to over 300 stations. Data on punch cards are also available for Toronto City back to 1918 and for St. Thomas, Ontario from 1937. Annually up-dated inventories are maintained by the Climatology Division and inquiries concerning card availability should be directed to Meteorological Branch Headquarters. Data on the punched card contains precipitation amounts, hourly, daily and monthly totals; intensities and dates on which they occurred. This card format replaces Electro #97997, published in Card Format Documentation, February 21, 1967, which now becomes obsolete. The design of this revised card format uses the ASIC (Archives Spread Item Card) concept, where 12 hours of data are punched into one card. All archival data of this card type now conform to this revised format.

GENERAL PRACTICES: Cards are punched from observations recorded on Form 63-2296, which are recordings of the MSC tipping bucket rain gauge used in conjunction with the MSC standard rain gauge. Some MSC tipping bucket rain gauges are heated and permit the measurement and recording of early spring, late fall and winter rains and freezing rains. Snow measurements though are not reliable and are not recorded unless the snow falls with rain. Normally two cards a day are punched. Card 1 contains the Total Daily Precip and hourly precip for hours 01-12. Card 2 contains the hourly precip for hours 13-24 with the greatest amount data. Two monthly cards are also punched - Card 1 contains the Total Monthly Precip and Card 2 contains the greatest amount data with dates of occurrences.

FORM OF PUNCHED CARD USED

Electro #104312 - Format effective May 1960.



CARD FORMAT DOCUMENTATION

CARD COL.	ITEM OR ELEMENT	CARD CODE	CARD CODE DEFINITION	REMARKS
1-2	Card Type	03	#3 Card	Regular network using MSC tipping bucket.
		0X 3	Special #3 Card	Special network using Fischer-Porter equipment.
3-9	Station Number	Any digit including X and Y as assigned	Seven digit listing number as assigned	This is a number assigned in the Climatology Division to organize station punched card decks into alphabetic order within a province or within a district of a province. As a rule, the first digit is the province, the second and third digits of the number are the district and the last four digits are assigned to facilitate alphabetic organization. In certain circumstances the first two digits are used to identify the province and territories.
10-11	Year	00 to 99	1900 to 1999	
12-13	Month	01 to 12	January-December	
14-15	Day	01 to 31	Day of month	If coded XX Card 1 - Monthly Amounts. Card 2 - Monthly Intensities with dates of occurrences.
		Numeric XX	Monthly card	
16	Card Number	1 or 2	If punched 1 card will contain Total Daily Precip. (cols. 17-20) and Hourly Precip. Hrs. 01-12 (cols. 21-56). If punched 2 card will contain Hourly Precip. for hours 13-24 (cols. 21-56) and greatest amount precip for duration indicated (col. 57-80)	When daily total precip is zero, and there are no greatest amount data, there will be no card 2. When daily total precip is missing, .01 or more or zero with greatest amount data, there will always be a card 1 and a card 2. If numeric XX in cols. 14-15 (denoting monthly card) card 1 and cols. 17-20 will contain the Total Monthly Precip. When Total Monthly Precip is zero there will be card 1 only.
17-20	Total Precip Daily or Monthly (see cols. 14-15)	Blank	Unknown	
		0000 to 9999	Zero amount to 99.99 inches	
		X in col 17	Daily Precip amount not corrected	Card 1 only.
		X in col 19	Indicates freezing daily precip	When daily precip is freezing there will be X overpunch in tens position of field.
		X in col 20	Indicates frozen daily precip	When daily precip is frozen there will be X overpunch in low order position of field.
21	Monthly Precip	X	Incomplete monthly data	
21-23	Hourly Precip	Blank	No precip	Hour ending 01 LST card 1.
		X space space	Unknown	
		Space 01 to 999	.01 to 9.99 inches	Hour ending 13 LST card 2.
		X in col 22	Indicates freezing precip	When hourly precip is freezing there will be X overpunch in tens position of hourly precip field.
		X in col 23	Indicates frozen precip	When hourly precip is frozen there will be X overpunch in low order position of hourly precip field.
24-26	Hourly Precip	See cols 21-23	See cols 21-23	Hour ending 02 LST card 1. Hour ending 14 LST card 2. See cols 21-23.
27-29	Hourly Precip	See cols 21-23	See cols 21-23	Hour ending 03 LST card 1. Hour ending 15 LST card 2.
30-32	Hourly Precip	See cols 21-23	See cols 21-23	Hour ending 04 LST card 1. Hour ending 16 LST card 2. See cols 21-23.
33-35	Hourly Precip	See cols 21-23	See cols 21-23	Hour ending 05 LST card 1. Hour ending 17 LST card 2. See cols 21-23.
36-38	Hourly Precip	See cols 21-23	See cols 21-23	Hour ending 06 LST card 1. Hour ending 18 LST card 2. See cols 21-23.

CARD FORMAT DOCUMENTATION

CARD COL.	ITEM OR ELEMENT	CARD CODE	CARD CODE DEFINITION	REMARKS
39-41	Hourly Precip	See cols 21-23	See cols 21-23	Hour ending 07 LST card 1. Hour ending 19 LST card 2. See cols 21-23.
41-42	Date of Greatest Amount in 5 mins	Blank 01 to 31	Unknown Day of month	
42-44	Hourly Precip	See cols 21-23	See cols 21-23	Hour ending 08 LST card 1. Hour ending 20 LST card 2. See cols 21-23.
43-44	Date of Greatest Amount in 10 mins	Blank 01 to 31	Unknown Day of month	
45-47	Hourly Precip	See cols 21-23	See cols 21-23	Hour ending 09 LST card 1. Hour ending 21 LST card 2. See cols 21-23.
45-46	Date of Greatest Amount in 15 mins	Blank 01 to 31	Unknown Day of month	
47-48	Date of Greatest Amount in 30 mins	Blank 01 to 31	Unknown Day of month	
48-50	Hourly Precip	See cols 21-23	See cols 21-23	Hour ending 10 LST card 1. Hour ending 22 LST card 2.
49-50	Date of Greatest Amount in 60 mins	Blank 01 to 31	Unknown Day of month	
51-52	Date of Greatest Amount in 120 mins	Blank 01-to 31	Unknown Day of month	
51-53	Hourly Precip	See cols 21-23	See cols 21-23	Hour ending 11 LST card 1. Hour ending 23 LST card 2.
53-54	Date of Greatest Amount in 6 hrs	Blank 01 to 31	Unknown Day of month	
54-56	Hourly Precip	See cols 21-23	See cols 21-23	Hour ending 12 LST card 1. Hour ending 24 LST card 2.
55-56	Date of Greatest Amount in 12 hrs	Blank 01 to 31	Unknown Day of month	
57-59	Greatest Precip in Period of 5 mins	Blank 000	Unknown No precip for period indicated .01 to 9.99 inches	Card 2 only.
60-62	Greatest Precip in Period of 10 mins	See cols 57-59	See cols 57-59	Card 2 only.
63-65	Greatest Precip in Period of 15 mins	See cols 57-59	See cols 57-59	Card 2 only.
66-68	Greatest Precip in Period of 30 mins	See cols 57-59	See cols 57-59	Card 2 only.

CARD FORMAT DOCUMENTATION

CARD COL.	ITEM OR ELEMENT	CARD CODE	CARD CODE DEFINITION	REMARKS
69-71	Greatest Precip in Period of 60 mins	See cols 57-59	See cols 57-59	Card 2 only.
72-74	Greatest Precip in Period of 120 mins	See cols 57-59	See cols 57-59	Card 2 only.
75-77	Greatest Precip in Period of 6 hrs	See cols 57-59	See cols 57-59	Card 2 only.
78-80	Greatest Precip in Period of 12 hrs	See cols 57-59	See cols 57-59	Card 2 only.

MAGNETIC TAPE DATA
from CARD TYPE # 4
JULY 21, 1970

GENERAL

SUMMARY FOR THE CLIMATOLOGICAL DAY: This tape format documentation was prepared for use with tape files produced from summaries of climatological day observations dating back to 1841. All revisions in reporting and punching procedures, as well as definitions of a climatological day as they existed from time to time are documented. Revised inventories are up dated annually by the Climatology Division and inquiries concerning data availability should be directed to this Division at Meteorological Branch Headquarters.

The criterion used for the inclusion of any station in the current phase of Archival data conversion to magnetic tape was, that the station should have a minimum of 10 years (120 months) of record. For "summer only stations" in the Prairie provinces, the criterion was relaxed to allow for stations with 10 or more summer seasons of record to be included in the Archival tape file.

Punched card files containing less than 10 years of record will remain in the punched card media until they meet the criterion for inclusion with the Archival tape files. All of the files stored in punched cards can be written to magnetic tape on request, in accordance with current fees schedule.

The Tape and Card Format Documentation are basically the same, but while converting punched card files to the tape media, codes have been standardized throughout all files, and discreet limitations were established for items or elements in the file. With the implementation of more modern techniques and methods, Archival data were re-quality-controlled before being written to tape, and now constitute a readily processable and far more accurate data file than has previously been possible.

Each station file is preceded by a station master card, the field definitions of which are given below. A station file can be interspersed with several master cards, each one denoting some change in the station history.

#4 Station Master Card

Cols.	Field	Comments
1-7	Listing Number	
8-9	Year	Date at which mast. infor.
10-11	Month	becomes effective
12-13	Digits '00'	
14-37	Station Name	
38-41	Province	
42-43	Two Letter Identifier	
44-47	Elev (feet)	
48-51	Latitude	Deg XX Min XX
52-56	Longitude	Deg XXX Min XX

MAGNETIC TAPE DATA
from CARD TYPE # 4
JULY 21, 1970

#4 Station Master Card (Cont'd)

Cols.	Field	Comments
57	Time Zone	
58-59	Climat Day Begins	LST hour
60-66	-open	
67-68	Ovr Pch Ctl	
69-77	-open-	
78	Last or only Flag	Punch 'L' for last or only master in file
79-80	Card Type	Punch '04'

WEATHER ELEMENTS REPORTED: The following observed weather elements, have been transcribed to magnetic tape: maximum and minimum temperatures, maximum and minimum relative humidities, 6-hour amount of precipitation, 24-hour amount of rainfall, snowfall and total precipitation, snow depth, days with freezing temperature, thunderstorm, rain or drizzle, freezing rain or drizzle, hail, snow or snow grains etc., fog or ice fog, smoke or haze, blowing dust or sand, blowing snow, wind speed equal to or greater than 32 m.p.h., wind speed equal to or greater than 39 m.p.h., the direction, speed and hour of the peak wind gust.

COMPUTED WEATHER ELEMENTS: The following weather elements have been computed for first order stations only: mean daily temperature, growing degree-days above 42 degrees, and heating degree-days below 65 degrees.

ROUND OFF PROCEDURES FOR MAXIMUM AND MINIMUM TEMPERATURES: Temperatures have been converted to whole degrees (^{o}F); where stations recorded temperatures to nearest tenth of a degree the following rule prevailed -

.1 to .4 - the decimal was dropped and read: i.e. 26.3 read 26, 33.4 read 33.

.5 - Up to December 1956 was adjusted to the nearest even whole degree i.e. 26.5 read 26, 27.5 read 28. January 1957, .5 was adjusted to the next whole degree above, i.e. 26.5 read 27, 27.5 read 28.

.6 to .9 - was adjusted to the whole degree next above, i.e. 28.7 read 29, 34.9 read 35.

ROUND OFF PROCEDURES FOR SNOWFALL: Snowfall has been transcribed to tape to a tenth of an inch. When stations recorded snowfall in fractions of an inch, the following rule prevailed: Up to December 1956, 1/4 and 3/4 inches were punched in the original source data card so that the sum of two such fractions remained the same after rounding off: In punching the first fraction was always rounded to the next tenth of an inch above and the second fraction was always rounded to the tenth below, thus:

Recorded	Punched
1/4 + 1/4	.3 + .2
1/4 + 3/4	.3 + .7
3/4 + 3/4	.8 + .7
3/4 + 1/4	.8 + .2
1/4	.3
3/4	.8
1/4 + 3/4 + 1/4	.3 + .7 + .3

From January 1957 onward, 1/4 and 3/4 inches were punched as .3 and .8 inches respectively.

DAYS WITH RAIN OR DRIZZLE: A day with rain or drizzle (Col.54) was counted when any measurable precipitation was recorded in 24-hourly rainfall (Cols. 38-41) which includes freezing precipitation and hail. The exceptions to the above rule are primary stations for the period January 1955 to June 1961 when a day with rain or drizzle refers to measurable liquid precipitation only.

CLIMATOLOGICAL DAY: The 24-hour period for the climatological day varies according to the type of station, the period of record, and the element observed.

First Order Stations:

At first order stations from 1878 to May 31, 1924 inclusive there was only one observation a day,and it was taken in the morning at 0700 LST. The climatological day began on day N following the 0700 LST observation, ended on day N + 1 at 0700 LST, and was credited to day N + 1 for all observed elements.

From June 1, 1924 to December 31,1932 inclusive if there was only one observation a day and it was taken in the morning at 0700 LST, the climatological day began on day N following the 0700 LST observation and ended on day N + 1 at 0700 LST and was credited to day N + 1 for all observed elements except the maximum temperature. The maximum temperature reading was taken as indicated above, but was credited to day N.

If two observations were taken each day, one in the morning at 0700 LST, and one in the evening at 1900 LST, the climatological day began on day N following the 1900 LST observation and ended on day N + 1 at 1900 LST and was credited to day N + 1 for all observed elements except the maximum temperature. For maximum temperature, the climatological day began on day N following the 0700 LST observation and ended on day N + 1 at 0700 LST and was credited to day N.

From January 1, 1933 to December 31, 1940 inclusive if there was only one observation a day, and it was taken in the morning at 0630 LST,the climatological day began on day N following the 0630 LST observation and ended on day N + 1 at 0630 and was credited to day N for all observed elements except two - minimum temperature and snow depth. The minimum temperature reading was taken as indicated above, but was credited to day N + 1.

The snow depth was the instantaneous reading at 0630 LST and was credited to the same date as read.

If two observations were taken each day, one in the morning at 0630 LST and one in the evening at 1830 LST, the climatological day began on day N following the 0630 LST observations and ended on day N + 1 at 0630 LST and was credited to day N for all observed elements except two. The minimum temperature reading was for the climatological day which began on day N following the 1830 LST observation and ended on day N + 1 at 1830 LST and was credited to day N + 1. The snow depth was the instantaneous reading at 0630 LST and was credited to the same date as read.

From January 1, 1941 to December 31, 1954 inclusive most stations took four observations daily at the fixed times of 0130, 0730, 1330 and 1930 EST, with some stations taking one to three observations. The climatological day began on day N following the 0730 EST observation and ended on day N + 1 at 0730 EST and was credited to day N for all observed elements except as follows. For the minimum temperature, the climatological day began on day N following the 1930 EST observation and ended on day N + 1 at 1930 EST and was credited to day N + 1. The snow depth was the instantaneous reading at 0730 EST and was credited to the same date as read.

From January 1, 1955 to May 31, 1957 inclusive most stations took four observations at fixed times - 0030, 0630, 1230 and 1830 GMT with some stations taking one to three observations. The climatological day began on day N following the 1230 GMT observation and ended on day N + 1 at 1230 GMT, and was credited to day N for all observed elements except that for the minimum temperature the climatological day began on day N following the 0030 GMT and ended on day N + 1 at 0030 GMT and was credited to day N. The snow depth was the instantaneous reading at 1230 GMT and credited to the same date as read. The maximum and minimum relative humidity were based on the instantaneous hourly readings for the period 0030 to 2330 LST. The peak wind gust hour entry was in Local Standard Time.

From June 1, 1957 to June 30, 1961 inclusive all notes are the same as for the period January 1955, to May 1957 except that observations were taken a half hour earlier, i.e. instead of 0030, 0630, 1230 and 1830 GMT they were at 0000, 0600, 1200 and 1800 GMT.

From July 1, 1961 to the present most stations take four observations daily at the fixed times of 0000, 0600, 1200 and 1800 GMT with some stations taking one to three observations. The climatological day begins on day N following the 0600 GMT observation and ends on day N + 1 at 0600 GMT. All elements observed are credited to the N except the snow depth which is the instantaneous reading at 1200 GMT, and credited to the same date as read.

Ordinary Climatological Stations:

At ordinary climatological station (indicated by an X or Y punch in Col.77), because the majority of the observers at these stations are cooperative observers, the times for taking the observation may vary from station to station. Generally, they are encouraged to take the observation twice a day as close to 0800 and 1700 LST as possible. These times may vary as much as one hour on either side of the time indicated. Some stations take the observation only once a day, in the morning, afternoon or evening.

From 1878 to December 31, 1932 inclusive: (1) If a single observation was taken each morning at 0800 LST, the climatological day began on day N following the 0800 LST observation and ended on day N + 1 at 0800 LST and was credited to day N + 1 for all observed elements.(2) If a single observation was taken each afternoon at 1700 LST,the climatological day began on day N following the 1700 LST observation and ended on day N + 1 at 1700 LST and was credited to day N + 1 for all observed elements. (3) If two observations were taken each day, one in the morning at 0800 LST and one in the afternoon at 1700 LST, the climatological day began on day N following the 1700 LST observation and ended on day N + 1 at 1700 LST,and was credited to day N + 1 for all observed elements.

From January 1, 1933 to the present: (1) If the observation is taken once a day in the morning at 0800 LST, the climatological day begins on day N following the 0800 LST observation and ends on day N + 1 at 0800 LST and is credited to day N for all observed elements, except the minimum temperature which is credited to day N + 1. Occurrences of fog, hail or thunderstorm, when recorded, are always credited to the calendar day local standard time. The snow depth is the instantaneous reading at 0800 LST on the last day of the month and is credited to that date. (2) If the observation is taken once a day in the afternoon at 1700 LST, the climatological day begins on day N following the 1700 LST observation and ends on day N + 1 at 1700 LST and is credited to day N + 1 for all observed elements. Occurrences of fog, hail or thunderstorm, when recorded, are always credited to the calendar day local standard time. The snow depth is the instantaneous reading at 1700 LST on the last day of the month and is credited to that date. (3) If two observations are taken each day, one in the morning at 0800 LST and one in the afternoon at 1700 LST,the climatological day begins on day N following the 0800 LST observation and ends on day N + 1 at 0800 LST, and is credited to day N for all observed elements except as follows. The climatological day for the minimum temperature begins on day N following the 1700 LST observation and ends on day N + 1 at 1700 LST and is credited to day N + 1. Occurrences of fog, hail or thunderstorm, when recorded, are always credited to the calendar day local standard time. The snow depth is the instantaneous reading at 0800 LST on the last day of the month and is credited to that date.

Note: Since January 1959, a selected number of ordinary climatological stations record the snow depth daily rather than on the last day of the month only.

REFERENCES TO TIMES OF OBSERVATIONS:

1. Circular 3963 Tec. 498, January 13, 1964 - Differences in Temperature Data from Ordinary Climatological Stations Arising from Once Daily Readings as Compared to Twice Daily Readings - W.R. Burrows.

2. Documentation Sheet #3-59, June 22, 1959 - The Climatological Day for Basic Temperature and Precipitation Data - issued by the Climatology Division, Meteorological Branch.

3. Index of Monthly Record of Meteorological Observations in Canada - January and July issues starting July 1964.

MAGNETIC TAPE CARD
from CARD TYPE # 4
JULY 21, 1970

SOURCE DOCUMENTS USED:

First Order Stations:

Form No.	Period
A	Up to 1910
A1, A2, A3, A4	1911 to 1939
2301	1940 to 1954
2311	1955 to June 1961
2322	July 1961 to present

Ordinary Climatological Stations (many varieties prior to 1932):

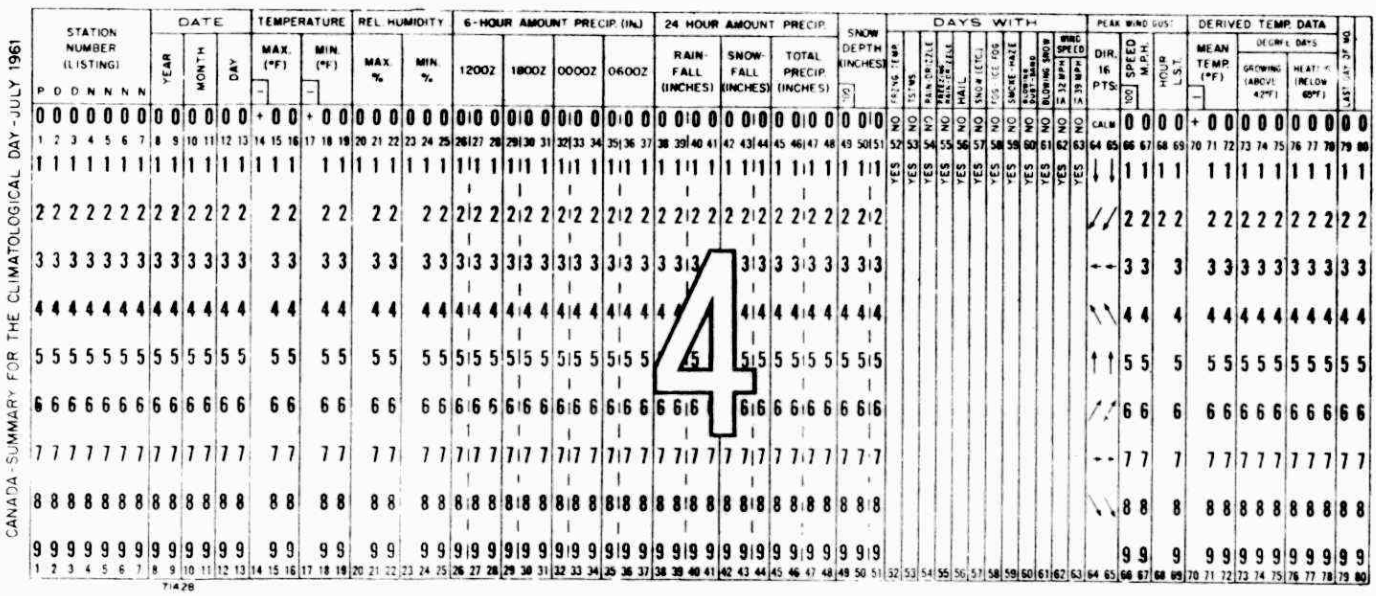
Form No.	Period
37A	1933 to 1938
2299, 2302-1, 2302-2, 2302-3, 2302-4	1939 to 1958
2300, 2304, 2305, 2313	1959 to present

NOTE: 2305 and 2313 are French versions of 2304.

REFERENCE TO NIPHER SNOW GAUGE:

"General Discussion of Discontinuities in Snowfall Data Resulting from the Introduction of the Nipher - Shielded Snow Gauge" - DS #1-64 January 9, 1964 - issued by the Climatology Division, Meteorological Branch.

This displays the original card type from which these data were transcribed to tape. For information regarding standardization of codes refer to detailed documentation.



TAPE FORMAT DOCUMENTATION

TAPE POSITION	ITEM OR ELEMENT	TAPE CODE	TAPE CODE DEFINITION	REMARKS	
1-7	Station Number	Any digit including X or Y over-punching as assigned	Seven-digit listing number as assigned	This is a number assigned in the Climatology Division to organize station punch card decks in alphabetic order within a province or within a district of a province. As a rule, the first digit is the province, the second and third digits of the number are the district and the last four digits are assigned to facilitate alphabetic organization. In certain circumstances the first two digits are used to identify the province and territories.	
8-9	Year	00-99 X over-punch Pos. 8	1900-1999 1800-1899		
10-11	Month	01-12	January-December	Before undertaking any studies involving time relationships, contact Climatology Division to establish time standards in use during the applicable station history. Also, see the general notes at the beginning of this booklet.	
12-13	Day	01-31	Day of Month		
14	Maximum Temperature Indicator	X 0 1 Blank	-01° to -70°F +00° to +99°F 100° to 120°F Unknown		
15	Maximum	X over-punch	Estimated	Maximum temperature position 14-16 is estimated effective December 1966.	
15-16	Maximum Temperature	00-99 Blank	-01° to -70°F 00° to 99°F 100° to 120°F Unknown	When position 14 is X, temperature is negative. When position 14 is 0, temperature is positive. When position 14 is 1, temperature is 100° to 120°F.	
17	Minimum Temperature Indicator	X 0 Blank	-01° to -90°F +00° to +99°F Unknown	If positions 18-19 blank	
18	Minimum	X over-punch	Estimated	Minimum temperature positions 17-19 is estimated effective December 1966.	
18-19	Minimum Temperature	00-99 Blank	-01° to -90°F 00° to 99°F Unknown	When position 17 is X, temperature is negative. When position 17 is 0, temperature is positive.	
20-22	Maximum Relative Humidity	010-100 Blank	10 to 100% Unknown	Positions 20-25 all have data or all are blank.	
23-25	Minimum Relative Humidity	010-100 Blank	10 to 100% Unknown		
26-28	6-hourly total precipitation up to June 1961 ending at 1830 GMT.	01-99 100-500	.01 to .99 inches 1.00 to 5.00 inches	Position 26 is blank.	These data available from 1st order stations only.
		0 3 Pos. 28	T for trace	Positions 26-27 are blank. Trace is less than .01 inches.	
	From July 1961 ending at 1200 GMT	000	0.00 inches		
		Blank	Unknown		
29-31	6-hourly total precipitation up to June 1961 ending at 0030 GMT	01-99 100-500	.01 to 99 inches 1.00 to 5.00 inches		These data available from 1st order stations only
		0 3 Pos. 31	T for trace		
	From July 1961 ending at 1800 GMT	000	0.00 inches	As per positions 26-28.	
		Blank	Unknown		
32-34	6-hourly total precipitation up to June 1961 ending at 0630 GMT.	01-99 100-500	.01 to .99 inches 1.00 to 5.00 inches		These data available from 1st order stations only.
		0 3 Pos. 34	T for trace		
	From July 1961 ending at 0000 GMT	000	0.00 inches	As per positions 26-28	
		Blank	Unknown		

TAPE FORMAT DOCUMENTATION

TAPE POSITION	ITEM OR ELEMENT	TAPE CODE	TAPE CODE DEFINITION	REMARKS	
35-37	6-hourly total precipitation up to June 1961 ending at 1230 GMT	01-99	.01 to .99 inches		These data available from 1st order stations only.
		100-500	1.00 to 5.00 inches		
		0 3 Pos. 37	T for trace		
	From July 1961 ending at 0600 GMT	000	0.00 inches		
		Blank	Unknown	As per positions 26-28	
38-41	24-hour rainfall at first order stations up to June 30, 1961 ending at 1230 GMT; from July 1, 1961 ending at 0600 GMT; at climatological stations ending approx. 0800 LST.	01-99	.01 to .99 inches	Positions 38-39 are blank.	
		100-999	1.00 to 9.99 inches	Position 38 is blank.	
		1000-2500	10.00 to 25.00 inches		
		0 3 Pos. 41	T for trace	Positions 38-39-40 are blank. Trace is less than .01 inch.	
		0000	No rainfall		
		X 3 Pos. 41	L indicates that it is not known whether rain fell on the day, but any that did fall will be accumulated on the next daily amount.	Positions 38-39-40 are blank. Neither L nor C is an amount of rain. No amount can be entered when the card contains this code. When an amount of rain has a control punch X in Position 38 (see notes on card code X Pos. 38), this means the amount represents more than one day. The number of days it represents depends on the number of L or C consecutive days preceding the day with the amount. L or C are not interchangeable. L means rain may or may not have occurred on date shown. Rain occurred during the period for which L is entered, but it is not certain on which specific day rain fell. C means rain did occur on date shown. Rain occurred at some time during each day for which C is entered.	
		Y 3 Pos. 41	C indicates rain fell on the day and that the next daily total will include this amount.		
		X overpunch or numeric X Pos. 38	Amount of rainfall entered in Pos. 38-41 represents a period more than 1 day.	Can be punched in combination with any amount of rainfall .02 inches or more.	
		Blank	Unknown		
39	24-hour rainfall	X overpunch or numeric X punch	Estimated	24-hour rainfall Positions 38-41 is estimated effective December 1966.	
42-44	24-hour snowfall at first order stations up to June 30, 1961 ending at 1230 GMT; from July 1, 1961 ending at 0600 GMT; at climatological stations ending approx. 0800 LST	1-9	.1 to .9 inches	Positions 42-43 are blank.	
		10-99 100-700	1.0 to 9.9 inches 10.0 to 70.0 inches	Position 42 is blank.	
		0 3 Pos. 44	T for trace	Positions 42-43 are blank, trace is less than .1 inches.	
		000	No snowfall		
		X 3 Pos. 44	L as in Pos. 41	Positions 42-43 are blank. For note on L and C see remarks for column 41.	
		Y 3 Pos. 44	C as in Pos. 41		
		X overpunch or numeric X Pos. 42	Amount of snowfall entered in Pos. 42-43 represents a period more than one day.	Can be punched in combination with any amount of snowfall .2 inches or more.	
		Blank	Unknown		
43	24-hour snowfall	X overpunch or numeric X punch	Estimated	24-hour snowfall positions 42-44 is estimated effective December 1966.	

TAPE FORMAT DOCUMENTATION

TAPE POSITION	ITEM OR ELEMENT	TAPE CODE	TAPE CODE DEFINITION	REMARKS	
45-48	24-hour precipitation at first order stations up to June 30, 1961 ending at 1230 GMT; from July 1, 1961 ending at 0600 GMT; at climatological stations ending approx. 0800 LST.	01-99	.01 to .99 inches	Positions 45-46 are blank.	Since November 1960 Nipher snow gauges have been installed at a gradually increasing number of first order stations. At these stations precipitation is given as rainfall plus the water equivalent of the snowfall. See the general notes at the front of this documentation for a reference dealing with the Nipher Snow Gauge.
		100-999	1.00 to 9.99 inches	Position 45 is blank.	
		1000-2500	10.00 to 25.00 inches		
		$\frac{0}{3}$ Pos. 48	T for trace	Positions 45-46-47 are blank.	
		0000	No Precipitation		
		$\frac{X}{3}$ Pos. 48	L as in position 41	Positions 45-46-47 are blank. For note on L and C see remarks for position 41.	
		$\frac{Y}{3}$ Pos. 48	C as in Pos. 41		
		X overpunch or numeric X Pos. 45	Amount of precipitation entered in Pos. 45-48 represents a period more than one day.	Can be punched in combination with any amount of precipitation .02 inches or more.	
		Blank	Unknown		
46	24-hour total precipitation	X overpunch or numeric X punch	Estimated	24-hour total precipitation positions 45 to 48 is estimated effective December 1966.	
49-51	Snow Depth	1-9	.1 to .9 inches	Positions 49-50 are blank. Fractions of inches were reportable values to end of December 1956.	
			1-9 inches	Positions 49 and 51 are blank. Whole inches only reportable values from January 1957.	
		10-99	10 to 99 inches	Position 51 is blank. Whole inches only reportable values from January 1957.	
		$\frac{X}{00}$ - $\frac{X}{99}$	100 to 199 inches		
		$\frac{Y}{00}$ - $\frac{Y}{99}$	200 to 299 inches		
		$\frac{0}{3}$ Pos. 51	T for trace	Positions 49-50 are blank.	
		000	No snow on ground		
		Blank	Unknown		
50	Snow Depth	X overpunch	Estimated	Snow depth positions 49-51 is estimated effective December 1966.	
52-63	Day with -	0	Phenomenon indicated did not occur		
52	Freezing temperature (32° or colder)	1	Phenomenon indicated did occur		
53	Thunderstorm				
54	Rain or drizzle (.01 inches or more)	Blank	Unknown		
55	Freezing rain or drizzle (trace or more)				
56	Hail (trace or more)				
57	Snow (.1 inches or more)				
58	Fog, ice fog				
59	Smoke, haze				
60	Blowing dust or sand				
61	Blowing snow				
62	Wind speed equal to or greater than 32 m.p.h.				
63	Wind speed equal to or greater than 39 m.p.h.				

TAPE FORMAT DOCUMENTATION

TAPE POSITION	ITEM OR ELEMENT	TAPE CODE	TAPE CODE DEFINITION	REMARKS
64-65	Direction of peak wind gust	00	Calm	These data available from January 1948. Positions 64-69 (direction, speed and hours) have all data or all are blank.
		11	North	
		12	North northeast	
		22	Northeast	
		32	East northeast	
		33	East	
		34	East southeast	
		44	Southeast	
		54	South southeast	
		55	South	
		56	South southwest	
		66	Southwest	
		76	West southwest	
		77	West	
		78	West northwest	
		88	Northwest	
		18	North northwest	
		X Pos. 64	There is more than one direction with same peak wind gust	The X is an overpunch. A wind direction code must be punched in the field.
		Blank	Unknown	
66-67	Speed of peak wind gust	19-99	19-99 m.p.h.	These data available from January 1955.
		X X 00 99	100-199 m.p.h.	Speed must be 19 m.p.h. or more.
		Blank	Unknown	
68-69	Hour of peak wind gust	00-23	Hour 00 to 23	These data are available from January 1955. Standard of time in effect: January 1955 - June 1961 Local Standard Time; July 1961 - Greenwich Mean Time.
		Blank	Unknown	
70	Mean temperature indicator	X 0	-00° to -99°F	Positions 70-78 all have data or all are blank.
		0	+00° to +99°F	
		Blank	Unknown	Information is not computed because maximum or minimum or both temperatures not observed.
71-72	Mean Temperature	00-99	00° to 99°F	When position 70 is X 0 temperature is negative. When position 70 is 0 temperature is positive.
		Blank	Unknown	Information is not computed because maximum or minimum or both temperatures not observed.
73	Growing degree-days indicator	X 0	Below base 42°F -00 to -99 degree-days	
		0	Above base 42°F 00 to 99 degree-days	
		Blank	Unknown	Information not computed because mean temperature not available.
74-75	Growing degree-days	00-99	00 to 99 growing degree-days	Base temperature for growing degree-days is 42°F. For every degree F above 42°F there is one unit of growing degree-days.
		Blank	Unknown	Information not available because mean temperature not available.

TAPE FORMAT DOCUMENTATION

TAPE POSITION	ITEM OR ELEMENT	TAPE CODE	TAPE CODE DEFINITION	REMARKS
76	Heating degree-days indicator	X 0	Above base 65°F -00 to -99 degree-days	Positions 70-78 all have data or all are blank.
		0	Below base 65°F 00 to 99 degree-days	
		1	100 or more	
		Blank	Unknown	Positions 77-78 are blank except as noted in card position 77 Type of Station card code X and Y. Information not computed because mean temperature not available.
77 over-punch	Type of station	X	Ordinary climatological station reporting temperature and precipitation	This definition of position 77 for code X and Y is entirely independent of heating degree-days data for positions 77-78.
		Y	Climatological station reporting only precipitation	
77-78	Heating degree-days	00-99	00 to 99 heating degree-days below 65°F	
		Blank	Unknown	Position 76 is blank. Information not computed because mean temperature not available.
79	Last day of month	X	Last day of month	Computed.
80	Unassigned	Blank		

APPENDIX C

GENERALIZED SWMM QUALITY MODEL,

USER'S MANUAL

APPENDIX C

GENERALIZED SWMM QUALITY MODEL

C.1 General

As indicated in Volume I of this report*, the current state-of--the-art of storm water quality modelling rarely justifies complex discretization of the catchment or the consideration of in-system storage. It was shown that it is possible to combine several small subcatchments into a single equivalent catchment without loss of accuracy in surface runoff quantity and quality simulations.

As a next step toward simplified quality modelling, the Generalized SWMM Quality Model (GSQM) was developed using the basic concepts of the quality algorithm used in the SWMM, in a less sophisticated formulation. An attempt was made to overcome several disadvantages of the SWMM quality routines as compared, for example, with those used in STORM. For instance, in some versions of SWMM the surface pollutant loading rates can be read into the model for various land uses. STORM also performs quality computations based on specified input hydrograph, if required. This permits a comparison of the pollutographs obtained from measured hydrographs or based on hydrographs from any runoff simulation model.

The GSQM represents a practical alternative to the use of SWMM with a coarse discretization. The Generalized model is easier to calibrate than SWMM because all parameters may be readily adjusted. The new model is potentially more accurate for the modelling of pollutant washoff than STORM because shorter time intervals may be used for washoff computations.

C.2 Features of Generalized SWMM Quality Model

The basic approach to runoff quality simulation used in GSQM is similar to that incorporated in the SWMM RUNOFF Block (documented in Figure 35, Volume I of this report*). Dust and dirt are accumulated at a rate dependent on the land use and total curb length. The total load accumulated over a catchment at the onset of a storm is determined from

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* Research Report No. 47, Storm Water Management Model Study, Volume I, Ottawa, 1976.

the product of the overall daily dust and dirt accumulation rate and the number of antecedent dry days. If street sweeping has occurred during the antecedent dry period, the total load is reduced according to the number of sweeper passes. Individual pollutant contributions are calculated from the total accumulated load based on the specified dust and dirt composition.

In many cases where local data on dust and dirt composition and accumulation rates are not available, the SWMM default values may be used for initial simulations. In this case the advantage of the GSQM is in the flexibility afforded to the user in calibration.

The main features of the GSQM are summarized below:

(A) Aggregated Single Catchment Model

The user can specify up to five land use types for the single catchment modelled. (In SWMM only one land use per subcatchment is permitted.) The overall accumulation rate for the catchment is determined from the total gutter length and dust and dirt accumulation rate for each land use. The concentration of pollutants in catch basins and the dust and dirt composition can be specified for each land use. This is particularly useful when local data are available.

(B) User Supplied Hydrograph

No runoff quantity computations are made in the GSQM. The user supplies the input hydrograph. This means that measured flows or flows from any runoff model can form the basis for quality simulations. The time step for quality computations can be adjusted to correspond to the time interval between points on the input hydrograph.

(C) Flows from Impervious Areas

For low intensity storms there is frequently no runoff from pervious areas. An option in the GSQM allows the user to specify this situation as an aid to model calibration for these storms. For larger storms the model can compute pollutant washoff over both pervious and impervious areas.

(D) No Transport System

The GSQM is designed for the simulation of surface runoff. Where the sewer system is combined and depositions from the dry weather flow are considered significant, the SWMM model should be used. Testing of the SWMM RUNOFF quality submodel (described in Volume I of this study) indicated that the detailed routing of surface runoff through a pipe system does not significantly affect the accuracy of quality simulations. For this reason pollutant routing and the decay of pollutants within the sewer system is not considered in the GSQM.

(E) Suspended Solids Computations

The GSQM provides the two options for the simulation of suspended solids computations included in SWMM (and described in detail in Chapter 5, Volume I of this study). Briefly, selection of (ISS=0) causes suspended solids computations to be based on the exponential washoff equation, and selection of (ISS=1) causes an empirical washoff equation to be used. Selection of the latter may facilitate calibration of the model for events having antecedent dry periods shorter than 10-15 days.

(F) Ten Pollutants

Ten pollutants are programmed in the GSQM, (BOD, COD, suspended solids, settleable solids, coliforms, N, PO_4, Cl, lead, oil and grease). However, the experienced user may simulate any other conservative pollutant by direct substitution. The computer output includes mass washoff curves and surface load data (before and after the storm) for each pollutant modelled.

(G) Computer Requirements

The GSQM is written in the same language as SWMM. In general, any computer system capable of accommodating SWMM

will also be suitable for the GSQM. The total storage requirement for the GSQM is approximately 80K bytes (or equivalent).

C.3 Model Calibration

The approach to the calibration of the GSQM is basically that used for calibration of SWMM (see Chapter 5, Volume I of this study). In the absence of local data, the main factor used for calibration of the GSQM is the dust and dirt accumulation rate (in some versions of SWMM this is altered by varying the antecedent dry period or curb length). If measured concentrations consistently exceed simulated concentrations, accumulation rates should be increased or vice versa. As with SWMM, adjustments to the first flush of suspended solids can be made by a change in the suspended solids availability factor and removing the coefficient for the empirical (ISS=1) equation (see also Chapter 5, Volume I of this study).

As noted above, the GSQM allows additional flexibility in simulating runoff from low intensity storms as the option (IFLOW=1) causes washoff from impervious areas only to be simulated. Also, the total washoff may be varied by adjustment of the exponential factor (B) in the exponential washoff equation (Chapter 5, Volume I of this report).

C.4 Data Input and Formats

The card group sequence required for the GSQM is indicated in Figure C.1 and the input data formats described in Table C.1. Additional background material describing the parameters listed here can be found in the EPA User's Manual and Volume I of this study. Table C.2 lists the description of variables used in the GSQM.

C.5 Example Application

An example of an application of the Generalized SWMM Quality Model to the Brucewood catchment (Figure C.2), located in North York, Toronto, is presented in this section. The catchment is described in more detail in Section 3.3.1 of Volume I, "Storm Water Management Study". For this example, the 48-acre catchment was modelled using two land use types: single family residential and open areas. The (ISS = 1) option

for the suspended solids computations and the normal flow method (IFLOW=0) for washoff rate calculations was used. A removal coefficient ("CC") value of 0.5 was used.

The data cards used for this example are shown in Table C.3. The computer print-outs of these input data are presented in Tables C.4 and C.5. The resulting output data from the simulation are summarized in Table C.6. The simulated values are compared with recorded values on Figure 89 of Volume I. A pollutant load history for each pollutant printed out by the model is given in Table C.7, which shows the total amount of a pollutant removed during the simulation.

The flow hydrograph used in this simulation is shown on Figure C.3. The computer plots for the settleable solids concentrations and loading rates are shown in Figures C.4 and C.5. The plot for the mass curve is presented on Figure C.6.

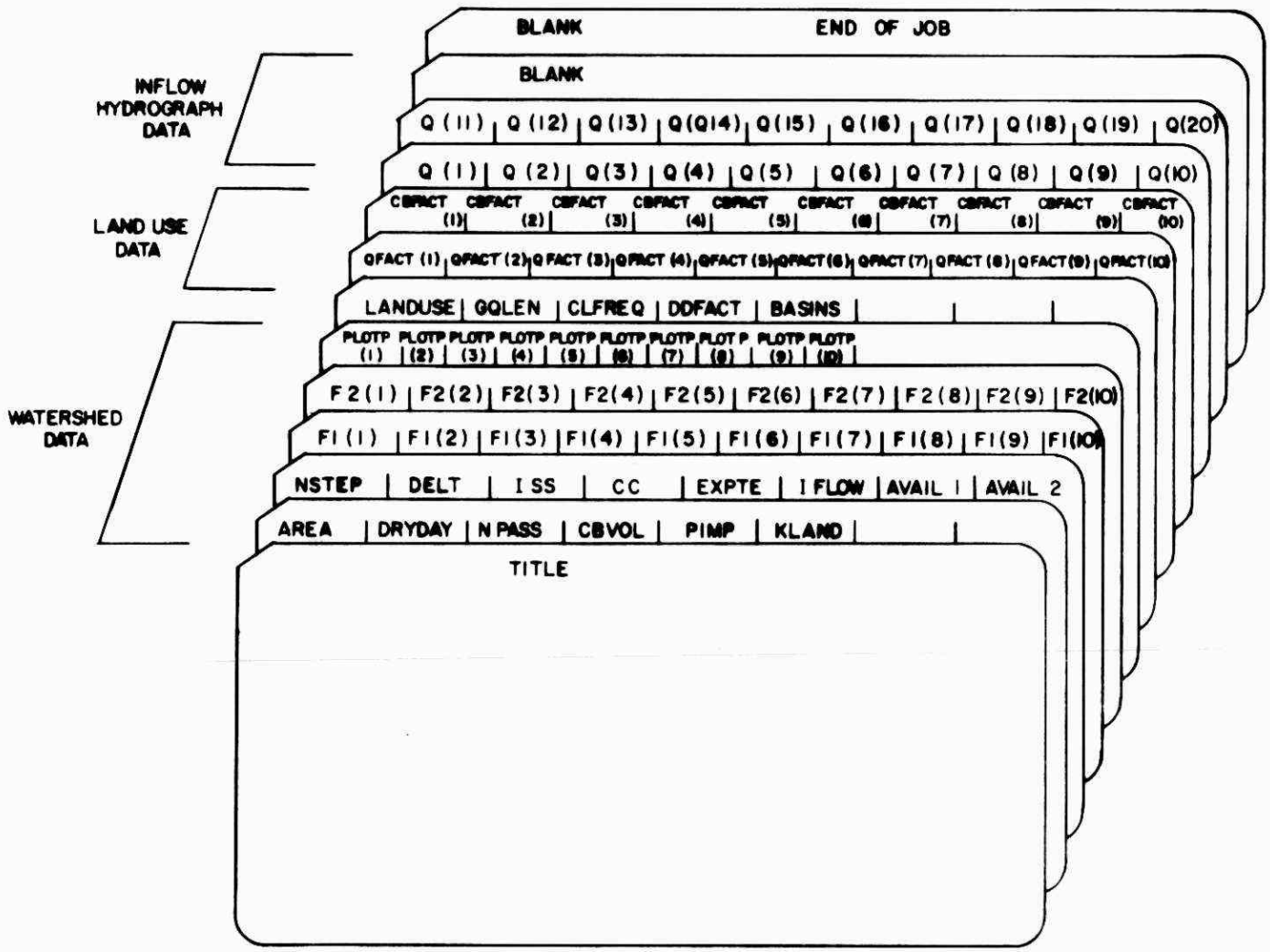
INFLOW HYDROGRAPH DATA
LAND USE DATA
WATERSHED DATA
BLANK
END OF JOB
BLANK
Q(11) Q(12) Q(13) Q(Q14) Q(15) Q(16) Q(17) Q(18) Q(19) Q(20)
Q(1) Q(2) Q(3) Q(4) Q(5) Q(6) Q(7) Q(8) Q(9) Q(10)
CBFACT (1) CBFACT (2) CBFACT (3) CBFACT (4) CBFACT (5) CBFACT (6) CBFACT (7) CBFACT (8) CBFACT (9) CBFACT (10)
QFACT (1) QFACT (2) QFACT (3) QFACT (4) QFACT (5) QFACT (6) QFACT (7) QFACT (8) QFACT (9) QFACT (10)
LANDUSE GQLEN CLFREQ DDFACT BASINS
PLOTP (1) PLOTP (2) PLOTP (3) PLOTP (4) PLOTP (5) PLOTP (6) PLOTP (7) PLOT P (8) PLOTP (9) PLOTP (10)
F2(1) F2(2) F2(3) F2(4) F2(5) F2(6) F2(7) F2(8) F2(9) F2(10)
FI(1) FI(2) FI(3) FI(4) FI(5) FI(6) FI(7) FI(8) FI(9) FI(10)
NSTEP DELT ISS CC EXPTE IFLOW AVAIL 1 AVAIL 2
AREA DRYDAY NPASS CBVOL PIMP KLAND
TITLE

FIGURE C.1. SUMMARY OF INPUT CARDS FOR GENERALIZED SWMM QUALITY MODEL

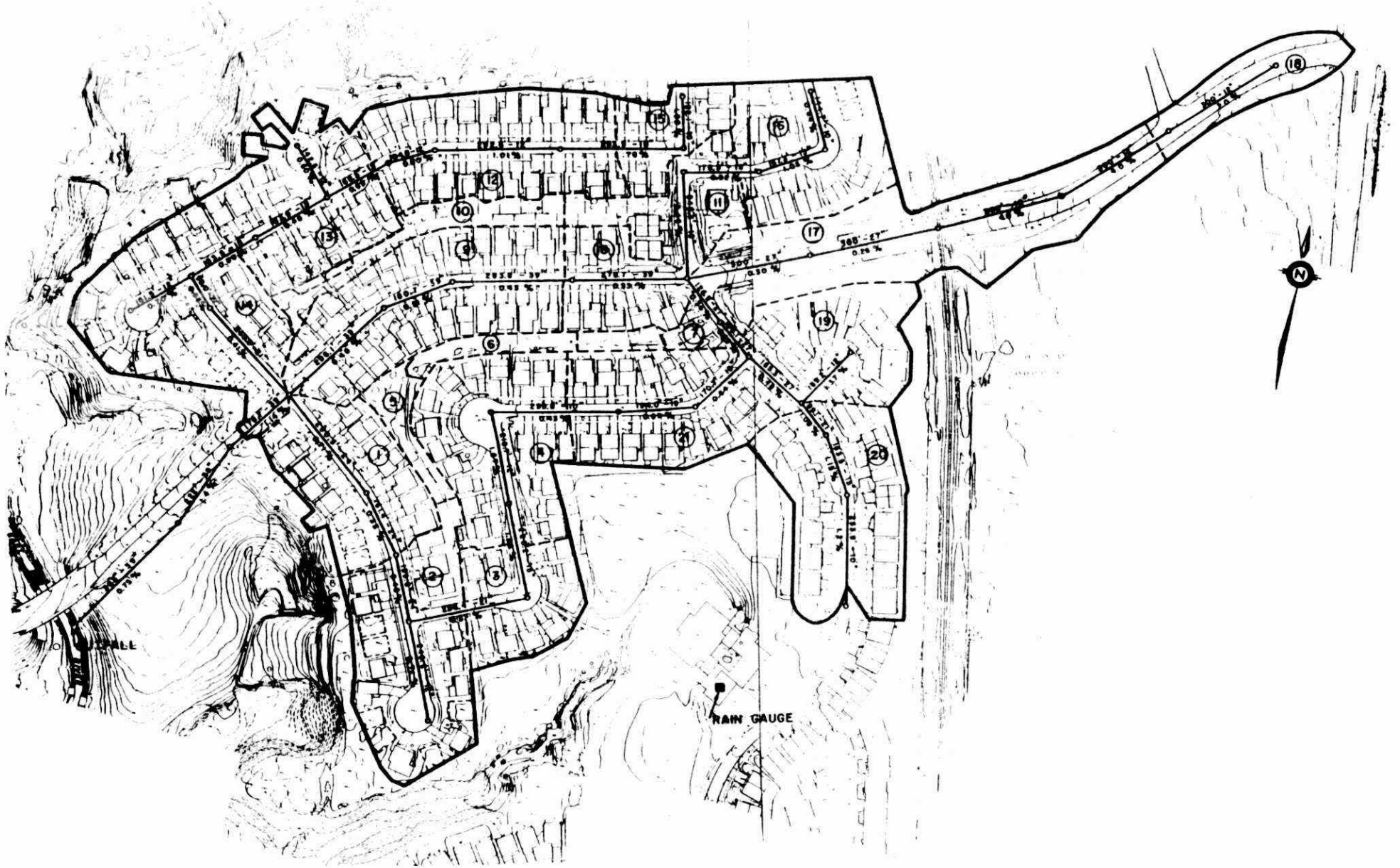

FIGURE C.2. STORM SEWER SYSTEM AND DRAINAGE SUBCATCHMENTS

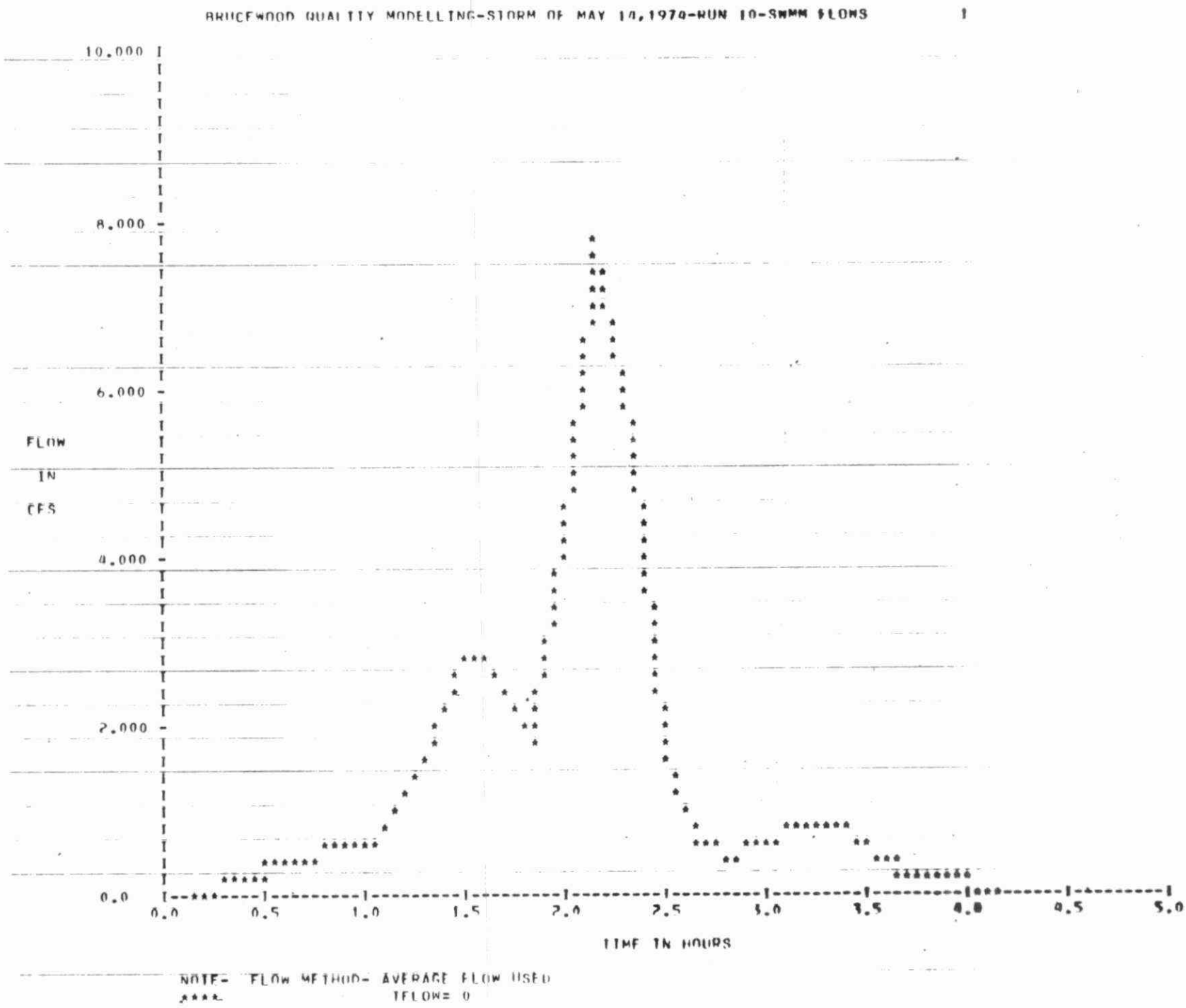

FIGURE C.3. INPUT HYDROGRAPH PLOT

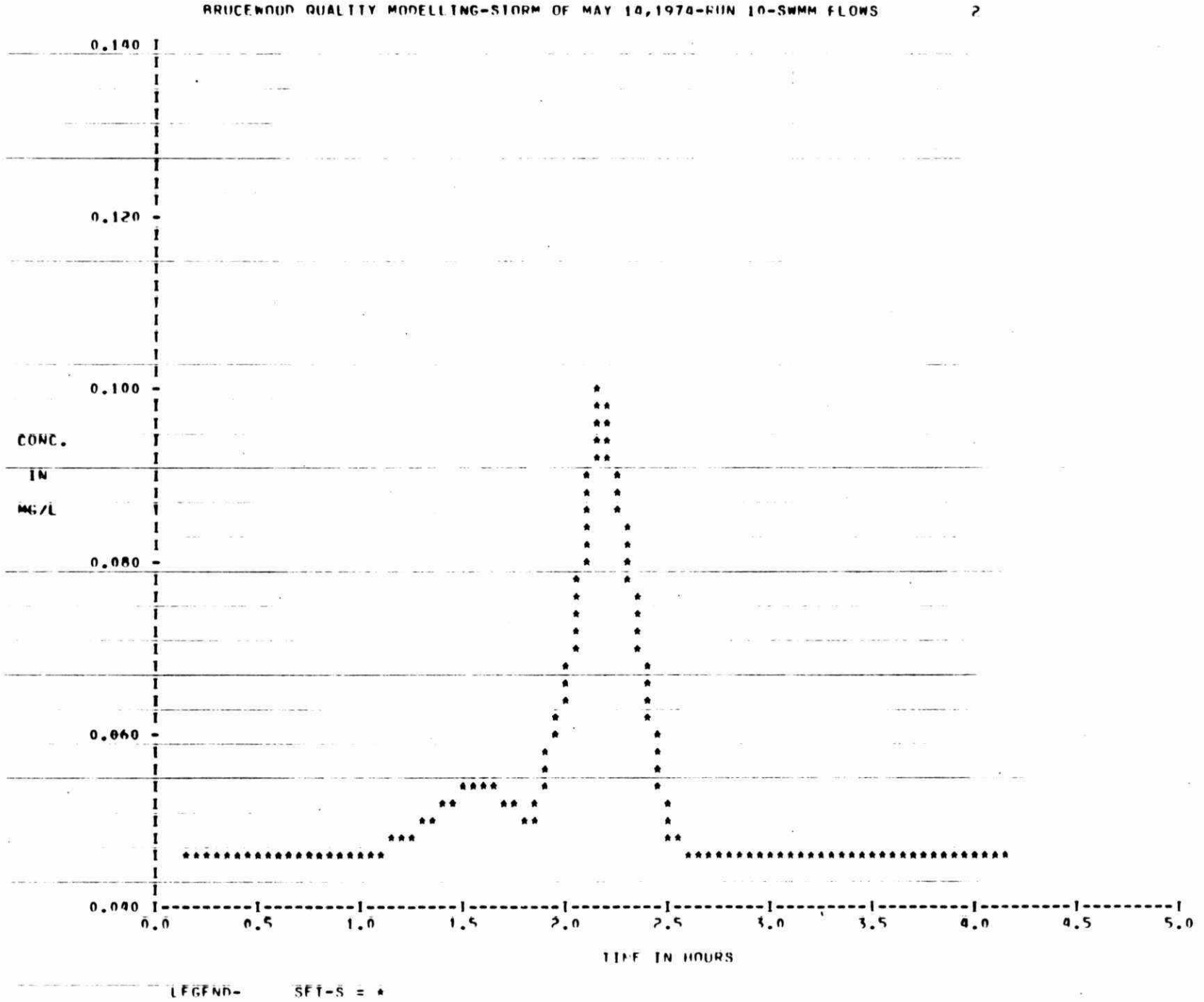

FIGURE C.4. SETTLEABLE SOLIDS POLLUTOGRAPH

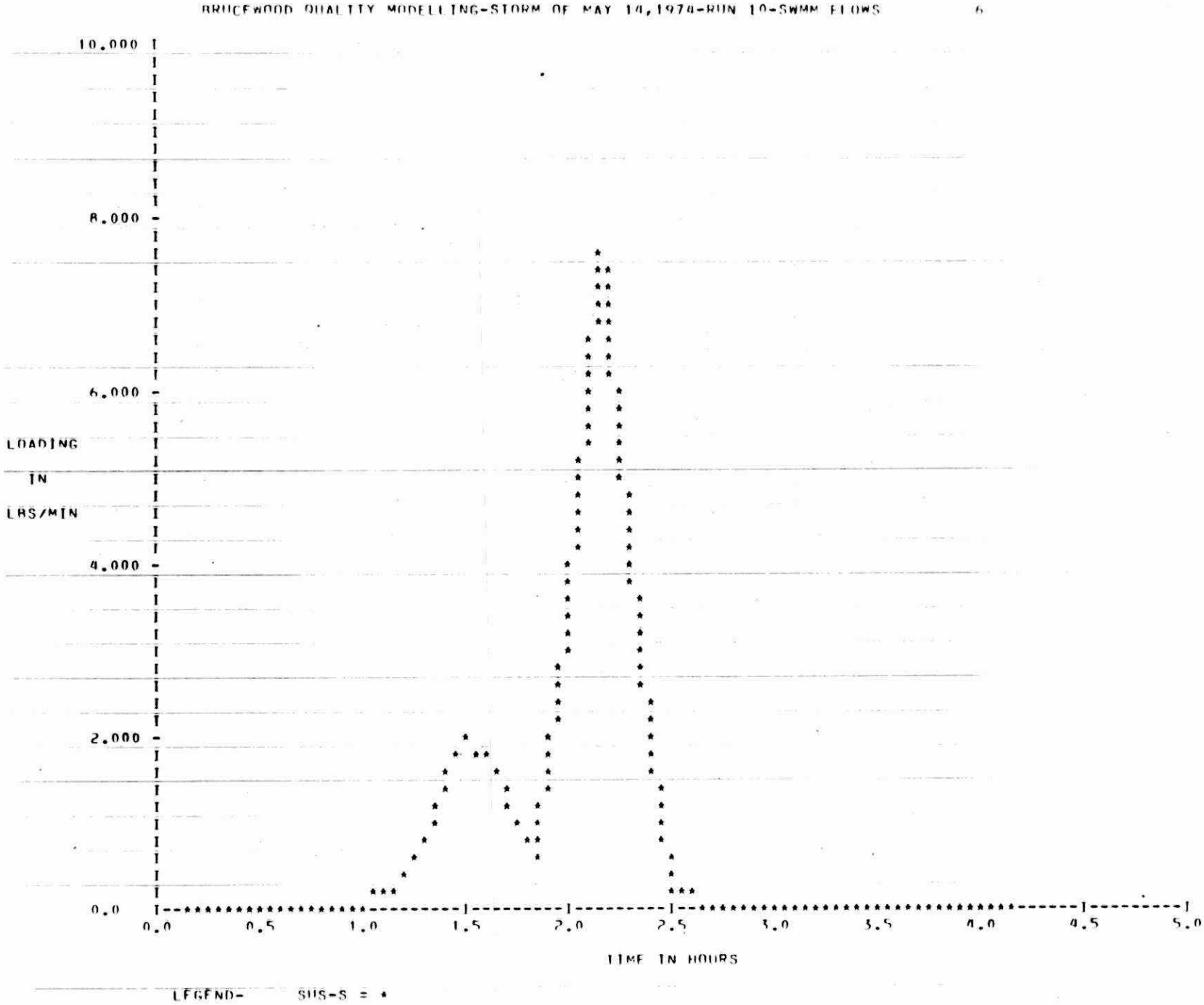

FIGURE C.5. INPUT HYDROGRAPH PLOT

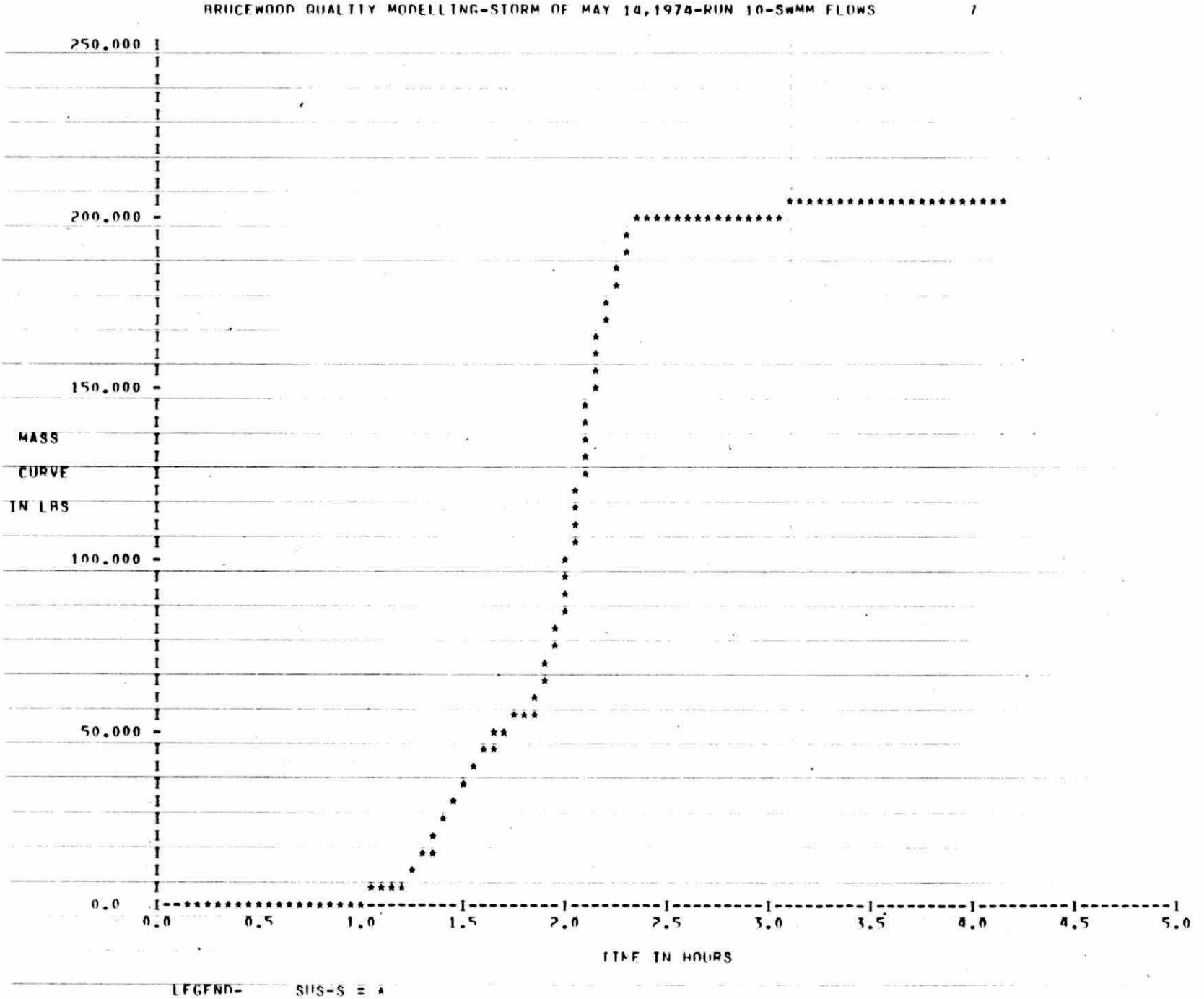

FIGURE C.6. MASS CURVE PLOT OF SUSPENDED SOLIDS

TABLE C.1. GENERALIZED QUALITY MODEL CARD DATA

Card Group	Format	Card Columns	Description	Variable Name	Default Value
1	18A4		Title card	TITL	Blanks
2			Control card one		
	F10.0	1-10	Watershed area in acres	AREA	None
	F10.0	11-20	No. of antecedent dry days (since last significant storm)	DRYDAY	0.0
	I10	21-30	Street sweeping passes (number of times sweeper travels along each curb during a street sweeping)	NPASS	1
	F10.0	31-40	Catchbasin volume in cu.ft.	CBVOL	0.0
	F10.0	41-50	Percent imperviousness of area	PIMP	0.0
	I10	51-60	No. of land uses (maximum = 5)	KLAND	None
3			Control card two		
	I10	1-10	No. of time steps to be calculated. (maximum = 200)	NSTEP	None
	F10.0	11-20	Integration period (time step) in seconds(1)	DELT	None
	I10	21-30	Method for calculating suspended solids ISS=0 same as all other pollutants ISS=1 Special Technique same as original release of the SWMM	ISS	0
	F10.0	31-40	Removing coefficient(2)	CC	0.9
	F10.0	41-50	Exponent 'B' used to calculate decay coefficient	EXPTE	4.6
	I10	51-60	Flow method IFLOW = 0 Average flow used IFLOW = 1 Average flow from imperviousness only used for washoff calculations	IFLOW	0

(1) Should equal time step for hydrograph input, Card Group 9.

(2) Required only if ISS=1.

TABLE C.1. (CONT'D)

Card Group	Format	Card Columns	Description	Variable Name	Default Value
	F10.0	61-70	Availability factor for settleable solids	AVAIL1	0.0
	F10.0	71-80	Availability factor for suspended solids (See EPA User's Manual for SWMM default values)	AVAIL2	0.0
4			Percent of settleable solids (one card) and suspended solids (one card) contributing to each pollutant (see EPA User's Manual for SWMM default values)	F1 F2	
	20F8.0	1-8	Percent of settleable solids contributing to pollutant 1(3)	F1(1)	0.0
		8-16	Percent of settleable solids contributing to pollutant 2	F1(2)	0.0
		. . . .			
5			Plot card	PLOTP	
	10I5	1-5	Pollutant number requiring separate plot	PLOTP(1)	0
		6-10	Pollutant number requiring separate plot	PLOTP(2)	0
		. . . .			
			Repeat card groups 6-8 inclusive for land uses as specified in card group 2	KLAND	

(3)

Pollutant No.	Pollutant	Pollutant No.	Pollutant
1	Settleable Solids	9	Lead
2	Suspended Solids	10	Chlorides
3	Total Coliforms		
4	BOD		
5	COD		
6	Total 'N'		
7	PO_4		
8	Oil and Grease		

TABLE C.1. (CONT'D)

Card Group	Format	Card Columns	Description	Variable Name	Default Value
6	I10	1-10	Land use type LNDUSE = 1 Residential LNDUSE = 2 Multi family LNDUSE = 3 Commercial LNDUSE = 4 Industrial LNDUSE = 5 Open or Park	LNDUSE	1
	F10.0	11-20	Total gutter length in hundreds of ft in this land use	GQLEN	0.1[4]
	F10.0	21-30	Cleaning frequency in days (number of days between street sweeping)	CLFREQ	None
	F10.0	31-40	Lbs of dust and dirt per hundred feet of curb	DDFACT	0.0
	I10	41-50	Total no. of catchbasins in this land use	BASINS	0
7			Breakdown of pollutants present		
	10F8.0	1-8	Mg of pollutant number 1 per gram of dust and dirt	QFACT(1)	0.0
		9-16	Mg of pollutant number 2 per gram of dust and dirt	QFACT(2)	0.0
		.			
		.			
		.			
		.			
8			Concentration of pollutants in catchbasins		
	10F8.0	1-8	Mg per litre of pollutant no. 1	CBFACT(1)	0.0
		9-16	Mg per litre of pollutant no. 2	CBFACT(2)	0.0
		.			
		.			
		.			
		.			

[4] This default value is non-zero to avoid computer underflow.

TABLE C.2. GENERALIZED QUALITY MODEL VARIABLES

Card Group	Format	Card Columns	Description	Variable Name	Default Value
9			Input hydrograph (as many cards as required)		
	10F8.0	1-8	Flow in cfs in time step one	Q(1)	0.0
		9-16	Flow in cfs in time step two	Q(2)	0.0
		.			
		.			
		.			
		.	Up to number of steps specified in card group 3		
10			Termination cards. Two blank cards will terminate program. If additional catchments are to be modelled, do not include two blank cards, but include new set of card groups 1 through 9. At the end of the last data set include two blank cards.		

TABLE C.2. (CONT'D)

Variable Name	Description	Units
AREA	Area of watershed	acre
AVAIL1	Availability factor for settleable solids	
AVAIL2	Availability factor for suspended solids	
BASINS	Number of catchbasins	
CC	Removing coefficient	
CBFACT	Concentration of pollutants in catchbasin	mg/l
CLFREQ	Frequency of street sweeping	days
CBVOL	Volume of liquid remaining in a catchbasin	cu ft
DDFACT	Dust and dirt accumulation rate for each land use area	
DELT	Integration time interval	sec.
DRYDAY	Number of dry days prior to storm	days
EXPTE	Decay coefficient	
F1	Percent of settleable solids contributing to each pollutant	%
F2	Percent of suspended solids contributing to each pollutant	%
GQLEN	Total curb length for each land use	100-ft
IFLOW	Control parameter for using a particular flow method	
ISS	Control parameter for calculating suspended solids	
KLAND	Number of land uses in watershed	
LANDUSE	Land use type	

TABLE C.2. (CONT'D)

Variable Name	Description	Units
NPASS	Number of street sweeper passes	
NSTEP	Total number of time steps	
PIMP	Percent imperviousness of watershed	%
PLOTP(I)	Parameter indicating whether or not plot is required for a pollutant	
Q(I)	Inflow for each time step	cfs

TABLE C.3. GENERALIZED QUALITY MODEL GSQM SAMPLE INPUT DATA
(Corresponds to Output in Tables C.4 to C.7)

```
(1) BRUCEWOOD SIMULATION STORM OF SEPT. 11,1975 (SWMM FLOWS)
(1) BRUCEWOOD QUALITY MODELLING-STORM OF MAY 14,1974-RUN 10-SWMM FLOWS
(2)     48.2          5.0          1          20.        51.8          2
(3)       25         600.          1         0.5         4.6          0          0          0
(4)                                2.0
(4)                                5.0
(5)   1     2     3     4     5
(6)         1       169.0          5.0          .7          75
(7)   11.0     1000.  0.27E07       5.0        40.0
(8)      0          0          0     30.0           0
(6)         5          0.1          5.0          1.5           0
(7)   11.0     1000.          0       5.0        20.0
(8)      0          0          0         0          0
(9)    .01       0.22       0.39       0.53       .49       .62      1.35      2.32      3.31      1.94
(9)   1.80       6.80       8.70       2.65       .88       .47       .48       .72       .95       .66
(9)    .39        .21        .13        .09        .06
```

TABLE C.4. INPUT PARAMETERS

```
                    QUALITY ANALYSIS
                    ****************

BRUCEWOOD QUALITY MODELLING-STORM OF MAY 14,1974-RUN 10-SWMM FLOWS

INPUT PARAMETERS

     AREA OF WATERSHED IN ACRES=      48.20
     NO. OF ANTECEDENT DRY DAYS=       3.00
     NO. OF STREET SWEEPING PASSES=       1
     CATCHBASIN VOLUME IN CU. FT.=    20.00
     PERCENT IMPERVIOUSNESS=          51.80
     TOTAL NUMBER OF LAND USES=           2

     TOTAL NO. OF TIME STEPS=   25
     TIME INTERVAL BETWEEN STEPS IN SECONDS=     600.00
     METHOD FOR CALCULATING SUSPENDED SOLIDS.  SPECIAL TECHNIQUE.  SAME AS ORIGINAL RELEASE 1 OF THE SWMM.
                                               ISS= 1

     REMOVING COEFFICIENT=  0.50
     EXPONENT B=  4.60
     FLOW METHOD.  AVERAGE FLOW USED
                   IFLOW= 0

     AVAILABILITY FACTOR FOR SETTLEABLE SOLIDS=  0.0
     AVAILABILITY FACTOR FOR SUSPENDED SOLIDS=  0.0


     PERCENT OF SETTLEABLE SOLIDS CONTRIBUTING TO POLLUTANTS

       SET-S     SUS-S     COLIF      BOD       COD       NIT       PO4     GREASE     LEAD        CL
         0.0       0.0       0.0      2.00      0.0       0.0       0.0       0.0       0.0       0.0

     PERCENT OF SUSPENDED SOLIDS CONTRIBUTING TO POLLUTANTS

       SET-S     SUS-S     COLIF      BOD       COD       NIT       PO4     GREASE     LEAD        CL
         0.0       0.0       0.0      5.00      0.0       0.0       0.0       0.0       0.0       0.0


SEPERATE PLOT REQUESTED FOR FOLLOWING POLLUTANTS

     SET-S
     SUS-S
     COLIF
       BOD
       COD
```

TABLE C.4. (CONT'D)

BRUCEWOOD QUALITY MODELLING-STORM OF MAY 14,1974-RUN 10-SWMM FLOWS

AREA NO. 1

LAND USE TYPE IS RESIDENTIAL
GUTTER LENGTH IN HUNDREDS OF FEET= 169.00
CLEANING FREQUENCY IN DAYS= 5.00
LB. OF POLLUTANT PER DAY PER 100 FT OF CURB= 0.70
NO. OF CATCH BASINS IN THIS LAND USE= 75

MG OF POLLUTANT PER GRAM OF DUST AND DIRT

SET-S	SUS-S	COLIF	BOD	COD	NIT	PO4	GREASE	LEAD	CL
11.00	1000.00	0.270E 07	5.00	40.00	0.0	0.0	0.0	0.0	0.0

MG/L OF POLLUTANT IN EACH CATCH BASIN

SET-S	SUS-S	COLIF	BOD	COD	NIT	PO4	GREASE	LEAD	CL
0.0	0.0	0.0	30.00	93.00	0.0	0.0	0.0	0.0	0.0

AREA NO. 2

LAND USE TYPE IS OPEN OR PARK
GUTTER LENGTH IN HUNDREDS OF FEET= 0.10
CLEANING FREQUENCY IN DAYS= 5.00
LB. OF POLLUTANT PER DAY PER 100 FT OF CURB= 1.50
NO. OF CATCH BASINS IN THIS LAND USE= 0

MG OF POLLUTANT PER GRAM OF DUST AND DIRT

SET-S	SUS-S	COLIF	BOD	COD	NIT	PO4	GREASE	LEAD	CL
11.00	1000.00	0.0	5.00	20.00	0.0	0.0	0.0	0.0	0.0

MG/L OF POLLUTANT IN EACH CATCH BASIN

SET-S	SUS-S	COLIF	BOD	COD	NIT	PO4	GREASE	LEAD	CL
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE C.5. INPUT HYDROGRAPH

BRUCEWOOD QUALITY MODELLING-STORM OF MAY 14,1974-RUN 10-SWMM FLOWS

INPUT HYDROGRAPH IN CFS. TIME STEP BETWEEN VALUES OF 600.0 SECONDS.

0.01	0.22	0.39	0.53	0.49	0.62	1.35	2.32	3.31	1.94
1.80	6.80	8.70	2.63	0.88	0.47	0.48	0.72	0.95	0.66
0.39	0.21	0.13	0.09	0.06					

TABLE C.6. SUMMARY OF QUANTITY AND QUALITY RESULTS

SUMMARY OF QUANTITY AND QUALITY RESULTS
****

BRUCEWOOD QUALITY MODELLING-STORM OF MAY 14,1974-RUN 10-SWMM FLOWS

FLOW METHOD- AVERAGE FLOW USED
IFLOW= 0
METHOD FOR CALCULATING SUSPENDED SOLIDS- SPECIAL TECHNIQUE. SAME AS ORIGINAL RELEASE 1 OF THE SWMM.
ISS= 1
TIME INTERVAL BETWEEN STEPS IN SECONDS= 600.00

FLOW IN CFS AND QUALITY IN MG/L (AND COLIFORMS IN MPN/L)

STEP	FLOW	SET-S	SUS-S	COLIF	BOD	COD
1	0.00	0.05	5.32	0.403E 06	19.75	64.07
2	0.11	0.05	8.45	0.403E 06	19.63	63.20
3	0.30	0.05	19.56	0.402E 06	19.24	60.27
4	0.46	0.05	30.41	0.399E 06	18.19	55.29
5	0.51	0.05	32.59	0.396E 06	16.47	49.62
6	0.55	0.05	33.99	0.393E 06	14.78	44.12
7	0.98	0.05	66.57	0.388E 06	14.26	37.40
8	1.83	0.05	132.25	0.380E 06	14.54	28.01
9	2.81	0.05	190.10	0.366E 06	14.27	18.09
10	2.62	0.05	152.62	0.351E 06	10.35	11.60
11	1.87	0.05	90.91	0.338E 06	6.30	8.63
12	4.30	0.06	205.70	0.322E 06	11.44	6.52
13	7.75	0.10	264.27	0.293E 06	13.90	4.78
14	5.66	0.08	159.59	0.264E 06	8.49	3.99
15	1.75	0.05	43.10	0.249E 06	2.63	3.72
16	0.67	0.05	12.68	0.244E 06	1.09	3.64
17	0.47	0.05	8.05	0.242E 06	0.86	3.60
18	0.60	0.05	10.85	0.240E 06	0.99	3.57
19	0.83	0.05	16.64	0.237E 06	1.28	3.53
20	0.80	0.05	15.82	0.234E 06	1.23	3.48
21	0.52	0.05	9.06	0.232E 06	0.89	3.44
22	0.30	0.05	4.56	0.230E 06	0.66	3.42
23	0.17	0.05	2.55	0.229E 06	0.56	3.41
24	0.11	0.05	1.85	0.229E 06	0.52	3.40
25	0.07	0.05	1.52	0.228E 06	0.50	3.39

TABLE C.7. POLLUTANT MONITORING SUMMARY

INITIAL LBS OF POLLUTANT AVAILABLE (COLIFORMS IN MPN)

SET-S	SUS-S	COLIF	BOD	COD	NIT	PO4	GREASE	LEAD	CL
3.91	355.35	0.958E 06	22.43	22.91	0.0	0.0	0.0	0.0	0.0

FINAL LBS OF POLLUTANT AVAILABLE (COLIFORMS IN MPN)

SET-S	SUS-S	COLIF	BOD	COD	NIT	PO4	GREASE	LEAD	CL
3.82	151.77	0.542E 06	8.67	8.04	0.0	0.0	0.0	0.0	0.0

TOTAL LBS OF POLLUTANT REMOVED (COLIFORMS IN MPN)

SET-S	SUS-S	COLIF	BOD	COD	NIT	PO4	GREASE	LEAD	CL
0.09	203.58	0.416E 06	13.76	14.88	0.0	0.0	0.0	0.0	0.0

APPENDIX D

STORM USER'S MANUAL

DRAFT

723-S8-L2520

GENERALIZED COMPUTER PROGRAM

URBAN STORM WATER RUNOFF

"STORM"

OCTOBER 1974

HEC HYDROLOGIC ENGINEERING CENTER

U S ARMY CORPS OF ENGINEERS

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COMPUTER PROGRAM 723-S8-L2520

URBAN STORM WATER RUNOFF

"STORM"

October
[redacted] 1974

THE HYDROLOGIC ENGINEERING CENTER
CORPS OF ENGINEERS, U. S. ARMY
609 SECOND STREET
DAVIS, CALIFORNIA 95616

FOREWORD

This document describes major revisions to both the program capabilities and input data structure of the original September 1973 version of the STORM program. The program was modified to include computations for the quantity and quality of runoff from nonurban areas, snowfall and snowmelt, and land surface erosion for urban and nonurban watersheds. The input data structure was reorganized to accommodate the new features of the program.

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"STORM"

INTRODUCTION

1. ORIGIN OF PROGRAM

The original version of this program was completed in January 1973 by Water Resources Engineers, Inc. (WRE) of Walnut Creek, CA while under contract with the Hydrologic Engineering Center (HEC). Parts of the program had been previously developed by WRE for the Environmental Protection Agency and the City of San Francisco. The HEC has revised the input and output formats of the program to conform to its standardized methods as well as making the program modifications noted in the Foreward.

2. PURPOSE OF THE PROGRAM

This program represents a method of analysis to estimate the quantity and quality of runoff from small, primarily urban, watersheds. Nonurban areas may also be considered. Land surface erosion for urban and nonurban areas is computed in addition to the basic water quality parameters of suspended and settleable solids, biochemical oxygen demand (BOD), total nitrogen (N), and orthophosphate (PO_4). The purpose of the analysis is to aid in the selection of storage and treatment facilities to control the quantity and quality of urban storm water runoff and land surface erosion. The model considers the interaction of seven storm water parameters:

precipitation and air temperature for rainfall/snowmelt;

runoff;

pollutant accumulation;

land surface erosion;

treatment rates;

storage; and

overflows from the storage/treatment system.

The program is designed for use with many years of continuous hourly precipitation records. It is a continuous simulation model but may be used for selected single events.

3. HARDWARE AND SOFTWARE REQUIREMENTS

This program is available for the IBM 360/50, UNIVAC 1108, and CDC 6600 or 7600 computer systems. It requires about 40,000 words of core storage and a FORTRAN IV compiler that accepts multiple ENTRY statements. Input is accomplished by card reader and possibly a tape/disk. Output is accomplished by a 132 position line printer. One to five additional tape/disk units are required for temporary storage during the processing. The only program differences between the three computer systems are due to ENCODE/DECODE type statements and the way in which multiple output files are handled. Up to three output files are generated on tape/disk for printing at the end of the job.

4. DESCRIPTION OF PROGRAM

a. Concepts. The quantity of urban runoff has traditionally been estimated by using a design storm through frequency-duration-intensity curves or some other statistical means based on rainfall records. Such approaches normally neglect the spacing between storms and the capacity of the urban system to deal with some types of storms better than others.

Often, through natural and artificial storage mechanisms, intense short duration storms may be completely contained within storage so that no untreated storm water overflows to receiving waters. Alternately, a series of closely spaced, moderately sized storms may tax the system to the point that excess water must be released untreated.

It would seem reasonable, therefore, to assume precipitation cannot be considered without the system; a storm cannot be defined by itself, but must be defined in light of the urban storm water facilities. It is for this reason that an approach was developed that would not only recognize the properties of duration and intensity, but would also consider storm spacing and the capacity of the urban storm water system.

Figure 1 shows, pictorially, the interrelationship of the seven stormwater elements considered in this approach to estimating storm water runoff quality and quantity. In this approach rainfall washes dust and dirt and the associated pollutants off the watershed to the treatment-storage facilities where as much storm water runoff as possible is treated and released. Runoff exceeding the capacity of the treatment plant is stored for treatment later. If at some point the storage facilities

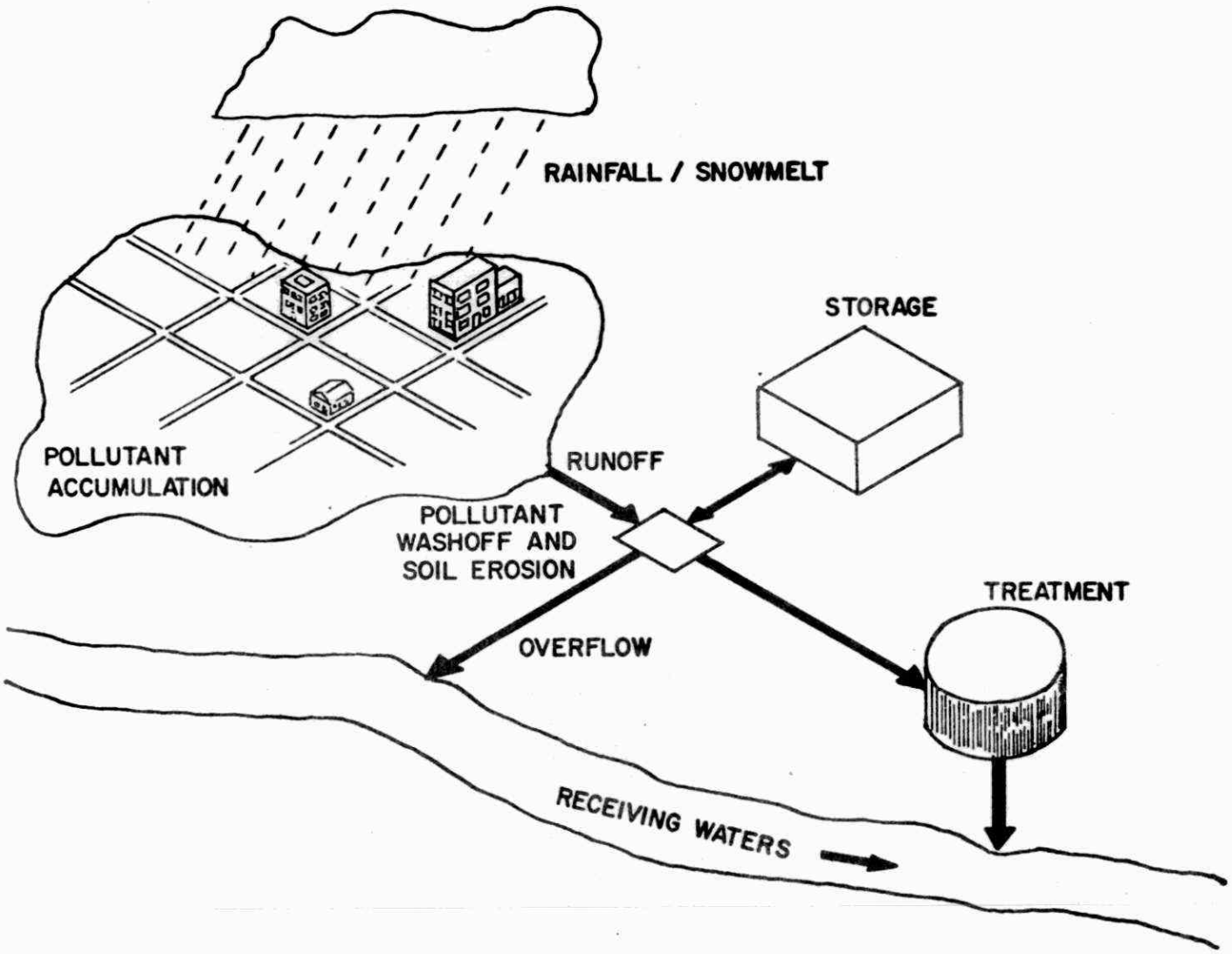


FIGURE 1

CONCEPTUALIZED VIEW OF URBAN SYSTEM
USED IN STORM

become inadequate to contain the runoff, the untreated excess is wasted through overflow directly into the receiving waters.

For a given rainfall/snowmelt record, the quantity, quality, and number of overflows will vary as the treatment rate, storage capacity, and land use is changed. Land surface erosion is a function of land use,

soil type, ground slope, rainfall/snowmelt energy, and erosion control practices. A typical method of investigation is to alter the treatment, storage, and land use and note the resulting response of the system. A group of alternatives can then be selected from among those meeting the overflow quantity and quality objectives.

The following sections describe the methodology of this approach of estimating urban runoff quantity and quality. The four major steps involved are 1) the computation of runoff, 2) the computation of runoff quality, 3) the computation of treatment, storage, and overflow, and 4) computation of land surface erosion.

b. Computation of Snowmelt. If snowfall/snowmelt computations are to be considered, the input hourly precipitation record must first be processed with a daily air temperature record for the same period of time. Snowmelt analyses are accomplished by the degree-day method as follows:

$$MELT = COEF * (\overline{T} - T_T), \; MELT \leq PACK \qquad (1)$$

where

MELT = snowmelt in basin inches;

COEF = degree day melt coefficient, usually about 0.05 - 0.1;

$\overline{T}$ = average daily air temperature, °F;

T_T = threshold temperature, °F, at which snow melts; and

PACK = available snowpack water equivalent in basin inches.

The input precipitation record is processed with daily average or max/min temperatures in order to determine snowfall or snowmelt conditions. When the average daily temperature is below a freezing threshold, the

precipitation during that day falls as snow and accumulates in a pack and there is no runoff. Conversely when the average daily temperature is above the freezing threshold, the snowpack melts and provides runoff in addition to rainfall, if any, during that period. The snow is assumed to melt from 0900 to 1700 hours. The resulting snowmelt and rainfall record replaces the original precipitation record as input to subsequent processing. Because rainfall energy is considerably larger than snowmelt energy for purposes of land erosion computations, days on which snowmelt occurs are flagged by negative signs so that the appropriate computations can be made for erosion.

c. Computation of the Quantity of Runoff

After the rainfall/snowmelt record is generated, runoff is computed separately for the urban and nonurban portions of the watershed. After the urban and nonurban runoff are computed, they are combined into total basin inches of runoff.

(1) Urban Runoff:

Urban runoff is computed as the following function of land use and rainfall/snowmelt losses.

$$r_u = C_u(P_u - f_u) \qquad (2)$$

where

r_u = urban area runoff in inches per hour;

C_u = composite runoff coefficient dependent on urban land use;

P_u = rainfall/snowmelt in inches per hour over the urban area, and

f_u = available urban depression storage in inches per hour.

The runoff coefficient represents losses due to infiltration. It is computed from land use data as follows:

$$C_u = C_p + (C_I - C_p) \sum_{i=1}^{L} X_i F_i \qquad (3)$$

where

C_p = runoff coefficient for pervious surfaces;

C_I = runoff coefficient for impervious surfaces;

X_i = area in land use i as a fraction of total urban watershed area;

F_i = fraction of land use i that is impervious; and

L = total number of urban land uses.

Before the runoff coefficient is applied, depression storage losses must be satisfied. Depression storage represents the capacity of the watershed to retain water in ditches, depressions and on foliage. The amount of depression storage at any point in time is a function of past rainfall/snowmelt and evaporation rates. The function is computed continuously by the following expression:

$$f_u = f_{ou} + N_D k_u, \quad f_u \leq D_u \qquad (4)$$

where

f_{ou} = available depression storage, in inches, after previous rainfall;

N_D = number of dry days since previous rainfall;

k_u = recession factor, in inches/day, representing the recovery (evaporation) of depression storage in inches;

D_u = maximum available depression storage in inches.

Before the runoff from the urban area is combined with the nonurban runoff, if any, it is subject to a diversion function. The flow which is diverted is considered lost from the system and is not used in any further computations. The equation for runoff is:

$$R_u = r_u - w_u(r_u - DVU_{min}) \text{ for } r_u \leq DVU_{max} \quad (5)$$

$$R_u = r_u - w_u(DVU_{max} - DVU_{min}) \text{ for } r_u > DVU_{max} \quad (6)$$

where

R_u = urban runoff after diversion;

r_u = urban runoff before diversion;

w_u = fraction of runoff between DVU_{max} and DVU_{min} diverted;

DVU_{min} = runoff at which diversion begins; and

DVU_{max} = runoff at which no additional diversion can occur.

(2) Nonurban Runoff :

Runoff from the nonurban area of the watershed is computed in a similar manner to that from the urban area. The only exception is that there is only one land use, "nonurban," and the runoff coefficient, C_n, is an input variable and not computed using equation 3. Equations 2, 4, 5 and 6 become:

$$r_n = C_n (P_n - f_n); \quad (7)$$

$$f_n = f_{on} + N_D k_n, \; f_n \leq D_n; \quad (8)$$

$$R_n = r_n - W_n(r_n - DVN_{min}) \text{ for } r_n \leq DVN_{maxj}, \text{ and} \quad (9)$$

$$R_n = r_n - W_n(DVN_{max} - DVN_{min}) \text{ for } r_n > DVN_{max}. \quad (10)$$

The variables have the same definition as indicated previously and the subscript "n" indicates "nonurban."

(3) Combined Urban and Nonurban Runoff

After the runoff from the urban, R_u, and nonurban, R_n, areas of the watershed have been computed, they are combined on an area weighted basis to reflect basin inches of runoff from the total watershed as follows:

$$R = (R_u A_u + R_n A_n)/(A_u + A_n) \quad (11)$$

where

R = basin inches of runoff from the total watershed;

A_u = urban area in acres, and

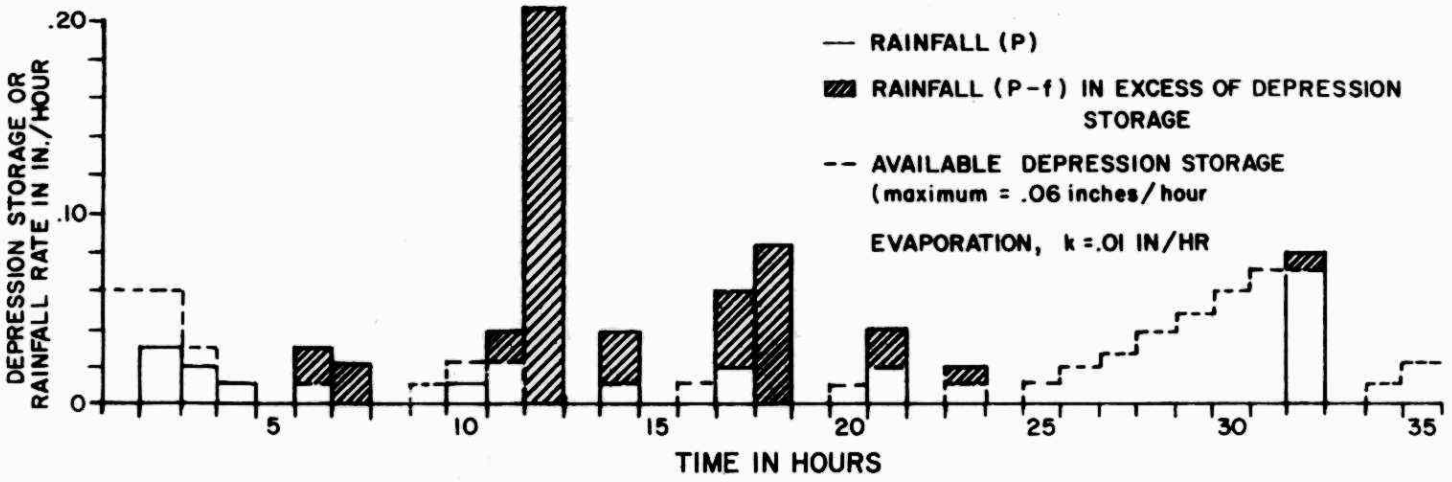
A_n = nonurban area in acres.

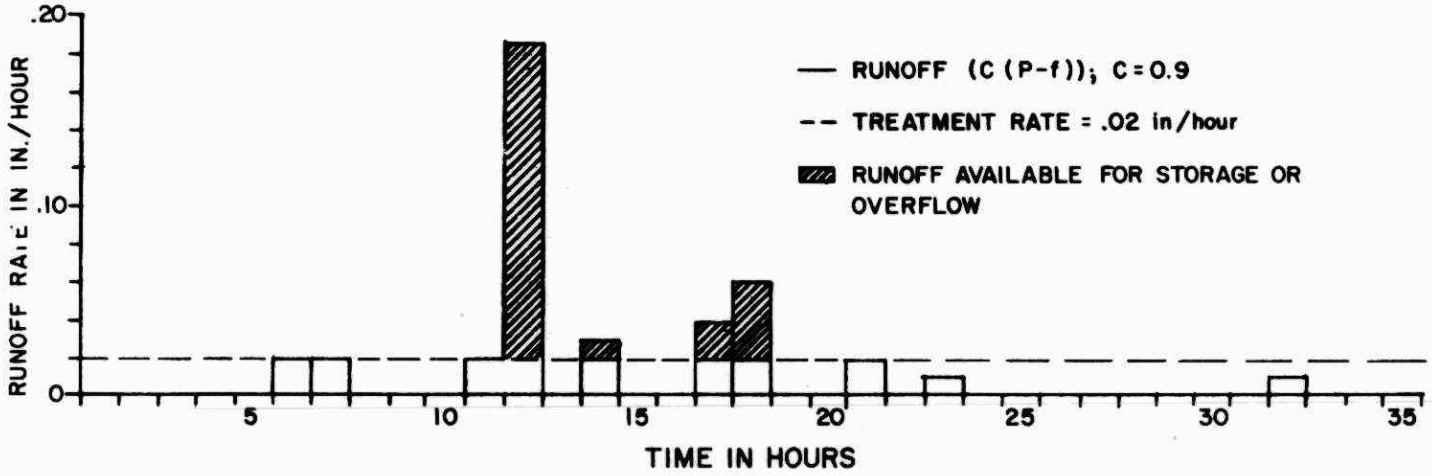
It is this runoff, R, that is subject to the storage/treatment analysis discussed later. Figures 2a and 2b show graphically the hourly precipitation (P), depression storage (f), excess rainfall/snowmelt (P-f) and the resulting runoff (R).

d. Computation of Quality of Runoff

(1) Quality of Urban Runoff

The most important contributor of pollutants in urban runoff is the waste and debris on the land surface. This occurs primarily as deposits in





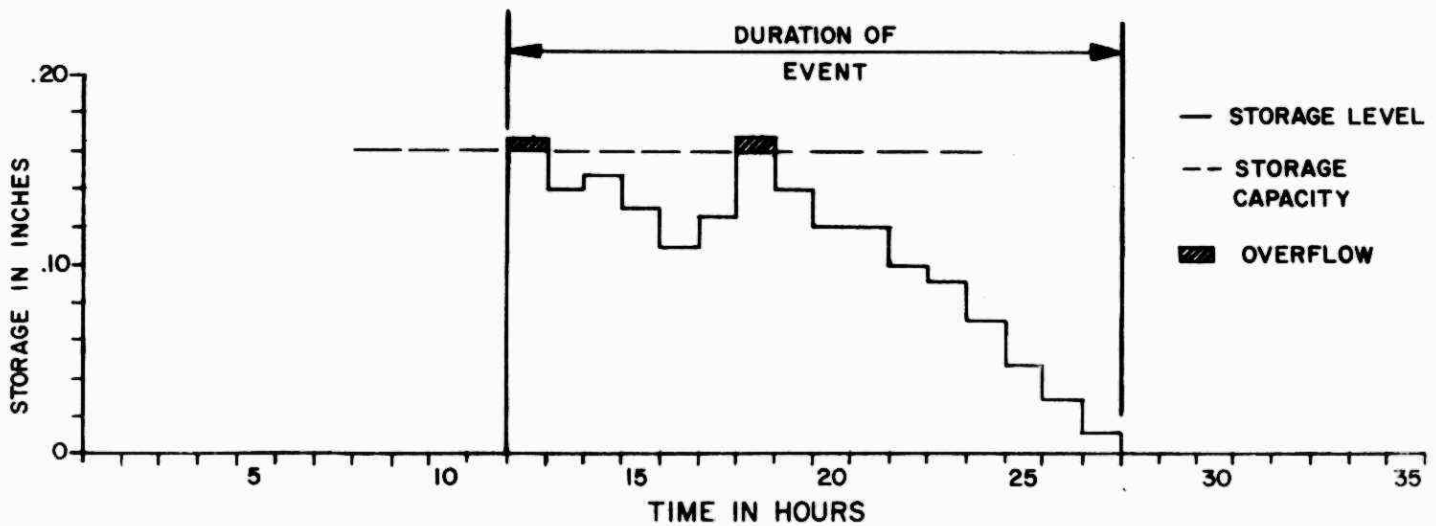


FIGURE 2a, b, c
TIME HISTORIES OF RAINFALL, RUNOFF, AND STORAGE

the streets and gutters and other impervious areas draining to the streets or storm sewers. Pollutants tend to accumulate on the land surface in many ways. Some of the most common accumulations occur in debris dropped or scattered by individuals, sidewalk sweepings; wastes and dirt from construction or renovation; remnants of household refuse dropped during collection or scattered by animals or wind; residue due to automobile exhaust and tires; and the fallout of particulate matter from the air. Irrespective of the way in which pollutants tend to accumulate on the urban watershed, they can be generally classified into one of the following categories of street litter: rags, paper, dust and dirt, vegetation, and inorganics. Based on street litter samples taken during the Chicago study (ref. a),, the most significant category is the dust and dirt except during the fall of the year when vegetation becomes the dominant component. Nearly all of the pollutants found in urban runoff can be associated with the dust and dirt component of street litter. Some of the most significant water quality parameters include suspended and settleable solids, chemical and biochemical oxygen demand, nitrogen, and phosphorous. Other pollutants found in urban runoff can include pesticides, herbicides, fertilizers, and numerous inorganic constituents. Data on the rate at which pollutants build-up on an urban watershed are almost non-existent, however, some information is presented in references a and b. The Chicago study ascertained the rate of build-up of dust and dirt in the streets of a number of different test areas and related the concentrations of various pollutants to the amount of dust and dirt. The pollutant accumulation rates of the Chicago study are incorporated into this program as default values. The default data should only be used if no water quality data are available for calibration of the model.

The computation of the quality of urban stormwater runoff involves a continuous analysis of the accumulation and washoff of the dust and dirt within the study area. The amount of pollutants washed into the storm drains and eventually to the treatment facilities or receiving waters is related to several factors including the intensity of rainfall, rate of runoff, the accumulation of dust and dirt on the watershed and the frequency and efficiency of street sweeping operations. The rate of dust and dirt accumulation, DD_L, for a given land use, L, can be expressed as:

$$DD_L = dd_L \ (G_L/100) \ A_L \qquad (12)$$

where

DD_L = rate of dust and dirt accumulation on land use L in lbs/day;

dd_L = rate of dust and dirt accumulation for land use L in lbs/day/100 feet of gutter;

G_L = feet of street gutter per acre for land use L, and

A_L = area of land use L in acres.

If the number of days since the last runoff is less than the street sweeping interval, the initial quantity of a pollutant c on land use L at the beginning of a storm is computed as:

$$P_p = F_p DD_L N_D + P_{po} \qquad (13)$$

where

P_p = total pounds of pollutant p on urban land use L at the beginning of the storm;

F_p = pounds of pollutant p per pound of dust and dirt;

N_D = number of days without runoff since the last storm, and

P_{po} = total pounds of pollutant remaining on land use L at the end of the last storm.

If the number of days without runoff is greater than the street sweeping interval, the following expression is used:

$$P_p = P_{po}\,(1-E)^n + N_s DD_L F_p[(1-E)^n + (1-E)^{n-1}+\ldots+(1-E)]$$

$$+ DD_L F_p(N_D - nNs) \qquad (14)$$

where

N_s = number of days between street sweepings,

n = number of times the street was swept since the last storm, and

E = efficiency of the street sweeping.

Finally, the expression used to compute the rate at which pollutants are washed off the watershed is

$$MU_p = P_p\,(1-e^{-E_u R_I \Delta t})/\Delta t \qquad (15)$$

where

R_I = runoff rate in inches/hour from impervious surfaces,

Δt = one hour, the fixed time interval in STORM, and

E_u = urban washoff decay coefficient

This equation must be modified, however, because not all of the dust and dirt on the watershed is available for inclusion in the runoff at a given time, t.

The following set of equations is used to calculate the rate of washoff, M, of the suspended solids (sus), settleable solids (set), biochemical oxygen demand (bod), total nitrogen (nit) and orthophosphate (PO_4).

$$MU_{sus}(t) = A_{sus}\,P_{sus}(t)\ \text{EXPT} \qquad (16a)$$

where

A_{sus} = availability of suspended material

$= 0.057 + 1.4R^{1.1}$

EXPT = $(1-e^{-E_u R_I})$ for $\Delta t = 1$ hour.

$$MU_{set}(t) = A_{set} P_{set}(t) \text{ EXPT} \tag{16b}$$

where

A_{set} = availability of settleable material

$= 0.028 + R^{1.8}$.

$$MU_{bod}(t) = P_{bod}(t) \text{ EXPT} + 0.10MU_{sus} + 0.02MU_{set} \tag{16c}$$

$$MU_{nit}(t) = P_{nit}(t) \text{ EXPT} + 0.045MU_{sus} + 0.01\ MU_{set} \tag{16d}$$

$$MU_{PO_4}(t) = P_{PO_4}(t) \text{ EXPT} + 0.0045MU_{sus} + 0.001MU_{set} \tag{16e}$$

If some of the urban runoff is lost due to the diversion option, the pollutant washoff is reduced by the ratio of the flows before and after diversion. That is

$$MU'_p = MU_p(R_u/r_u) \tag{17}$$

where

MU'_p = pounds/hour of pollutant after urban diversion works;

MU_p = pounds per hour of pollutant p before urban diversion;

R_u = urban runoff after diversion; and

r_u = urban runoff before diversion.

(2) Quality of Nonurban Runoff

The quality of nonurban runoff is computed similarly to the urban quality washoff methods. Because there are no streets or gutters in the nonurban areas, the pollutant accumulations are in terms of pounds per day per acre for each constituent. The nonurban equivalent of equations (12) and (13) is

$$PN_p = PA_p A_n N_D + PN_{po} \tag{18}$$

where

PN_p = total pounds of pollutant p on the nonurban area, A_n, at the beginning of the storm;

PA_p = accumulation rate for pollutant p in pounds/day/acre;

A_n = nonurban area in acres;

N_D = number of days without runoff since the last storm; and

PN_{po} = total pounds of pollutant p remaining on the nonurban area at the end of the last storm.

The washoff of nonurban pollutants is a function of only the nonurban runoff rate and the amount of pollutants on the watershed. Equation (15) as modified for nonurban runoff is shown below.

$$MN_p = PN_p \, (1-e^{-E_n r_n \Delta t})/\Delta t \tag{19}$$

where

MN_p = pounds washoff of pollutant p during time Δt (one hour);

E_n = nonurban washoff decay rate; and

r_n = rate of nonurban runoff in inches/hour.

No analysis of the availability of pollutants, such as in equation (16), is made for the nonurban pollutants.

Nonurban runoff is also subject to diversion losses and the pollutants are handled similar to equation (17) as follows:

$$MN'_p = MN_p \ (R_n/r_n) \qquad (20)$$

where

MN'_p = pounds/hour of pollutant p after nonurban diversion and the variables are as previously defined.

(3) Combined Quality of Urban and Nonurban Runoff

The pounds/hour of pollutant washoff after diversion, from the urban and nonurban areas are added together before being introduced to the storage/treatment system. The resultant pollutant output is

$$M_p = MU'_p + MN'_p \qquad (21)$$

for each hour of runoff.

e. Computation of Storage, Treatment and Overflow

Computations of treatment, storage, and overflow proceed in an hourly step-by-step method throughout a period of rainfall/snowmelt record. Every hour in which runoff occurs, the treatment facilities are utilized to treat as much runoff as possible. When the runoff rate exceeds the treatment rate, storage is utilized to contain the runoff. When runoff is less than the treatment rate, the excess treatment rate is utilized to diminish the storage level. If the storage capacity is exceeded, all excess runoff overflows into the receiving waters and does not pass through the storage facility. This overflow is lost from the system and cannot be treated later. While the storm runoff is in storage its age is increasing. Various methods of aging are used including average, first-in:last-out, first-in: first-out, or others, depending on the physical conditions encountered.

The computation of storage and the interplays among rainfall/snowmelt, storage, and treatment represent a simplistic approach to dividing a rainfall record into unique events such that the event is defined in light of the urban system. For example, whether two "storms" are considered as two isolated occurrences or as one large storm is entirely dependent upon how the system will react to them. If the system has not recovered from the first when the second arrives, the two definitely will interact and hence must be considered together. "Events" are defined as beginning when storage is required and continues until the storage reservoir is emptied. All the rainfall occurring within this period is part of the same event. If precipitation produces runoff that does not exceed the treatment rate, the runoff will pass through the treatment process not causing an event. From the standpoint of the urban stormwater system, such precipitation is inconsequential and hence is not part of an "event" even if it should occur immediately preceding an event.

The runoff coming into the storage/treatment system was computed in equations (11) and (17). The quantity of the system overflows are computed below.

$$Q_o = R - Q_T - Q_S \tag{21a}$$

$$Q_T = \text{minimum of } (R + Q_{S_{t-1}}, T) \tag{21b}$$

$$Q_S = \text{minimum of } (R - Q_T, S) \tag{21c}$$

where

Q_o = basin inches of runoff overflow,

Q_T = basin inches of runoff treated,

Q_S = basin inches of runoff stored,

$Q_{s_{t-1}}$ = basin inches of storage remaining in previous hour,

R = basin inches of runoff as calculated in equation (11),

T = treatment rate in basin in basin inches/hour, and

S = storage capacity in basin inches.

The quality of the system overflows are computed as follows for each pollutant for each hour.

$$M_{po} = Mp(Q_o/R) \qquad (22e)$$

$$M_{pT/s} = M_p - M_{po} \qquad (22d)$$

where

M_{po} = total pounds of pollutant overflowing from system,

M_p = total pounds of pollutant p coming into the system as computed in equation (17), and

$M_{pT/s}$ = total pounds of pollutant p going to storage/treatment system.

The program does not model the treatment process but it does compute the quantity of water treated. It is assumed that the pollutants will be reduced to an acceptable level before the storm water is released. The age of storage is computed as previously mentioned.

f. Computation of Land Surface Erosion

(1) Soil Erosion Equation

The universal soil-loss equation, presented by Walter Wischmeier and Dwight Smith (references c and e) is used to calculate soil erosion. This empirical equation was developed for cropland east of the Rocky Mountains. One would question the validity of results obtained by applying it to crop land that is located west of the Rocky Mountains much less to an urban area.

However, if one were starting from scratch to develop a soil erosion equation for urban areas and areas west of the Rocky Mountains, one could not identify more relevant variables than those presented in the universal soil-loss equation. Therefore, it is the calibration of these variables using crop land erosion data east of the Rockies that raises points of concern--not the basic equation, itself.

The equation and a brief description of each variable follows:

$$\text{Soil Erosion Rate} = EI \cdot K \cdot (L \cdot S) \cdot C \cdot P \qquad (23)$$

where

Soil Erosion Rate = Soil eroded from a plot in tons/acre/storm;

EI = Rainfall factor based on rainfall/snowmelt energy

K = Soil erodibility factor based on soil properties in Table 2 of reference d;

L·S = Length-slope factor, a function of ground surface slope and length of that slope as follows:

$L \cdot S = \sqrt{\text{slope-length}(L)}\ (.0076 + .0053\underline{S} + .00076\underline{S}^2)$ where S is ground slope in percent and is associated with soil properties, Table 1 of reference d.

C = Cropping-management factor represents ground cover and includes the likelihood that a surface layer of coarse grained particles can develop if the soil is not worked; and

P = Erosion-control practice factor accounts for contouring, sediment basins, etc.

Rainfall factor. Although the rainfall factor is calculated from rainfall intensity, it is based on raindrop size versus terminal velocity as determined by a regression equation. A basic assumption is that rain storm events west of the Rocky Mountains produce rain drops which obey this same regression equation. This assumption seems reasonable. Snowfall,

however, produces no impact energy and yet, the resulting runoff erodes the land. Therefore, the EI value from snowmelt is arbitrarily decreased to 1/3 of the value for an equivalent rainfall excess. This is based on a 20/40 distribution of snowmelt to rainfall erosive energy.

Length-slope factor. The length used in this factor should be the overland flow distance to the point where a stream or gully is encountered. Construction can change that distance. Slope length would then be measured as the lot dimension in the direction of ground surface slope. The objective is to relate the length of the slope being analyzed to the length of the standard soil erosion test plots used to develop the soil erosion coefficients.

Cropping-management factor is used to reduce erosion rate due to the presence of ground cover. The following values are suggested.

Table 1. Ground Cover Factors

Ground cover or treatment	C Factor %	Remarks
Bare ground	100	
Natural terrain		existing conditions
Seed and fertilizer (1)	60	during 18-20 mo. constr. period
Seed, fertilizer & straw mulch (1)	30	" " " " " "
Erosion control chemicals A&B (1)	90	" " " " " "
Erosion control chemical X (1)	60	" " " " " "
Grass cover (2)	1	
Land denuded by fire (judgment)	100	

(1) Reference f, p. 85.

(2) Reference c, p. 14.

Erosion Control Practice Factor. The following values are suggested in reference c, pp. 36-37.

Table 2. Erosion Control Practice Factors

Practice	Land Slope (%)	P (%)
No consideration	-	100
Contouring	<12	60
Contouring	12-18	80
Contouring	18-24	90
Contour stripcropping	<12	40
Contour stripcropping	12-18	60
Contour stripcropping	18-24	70

The values suggested for C and P are subjective; therefore, field verification is needed. The Soil Conservation Service should be consulted for additional information regarding local conditions.

(2) Erosion of Terrain

The soil erosion variables, except for EI, are coded into the computer program so that one need only to specify the soil type by its classification code (BtB, HaC, ..., etc.) and the program will calculate the erosion rate and total erosion. An example of soil map showing soil types is illustrated in the following figure.

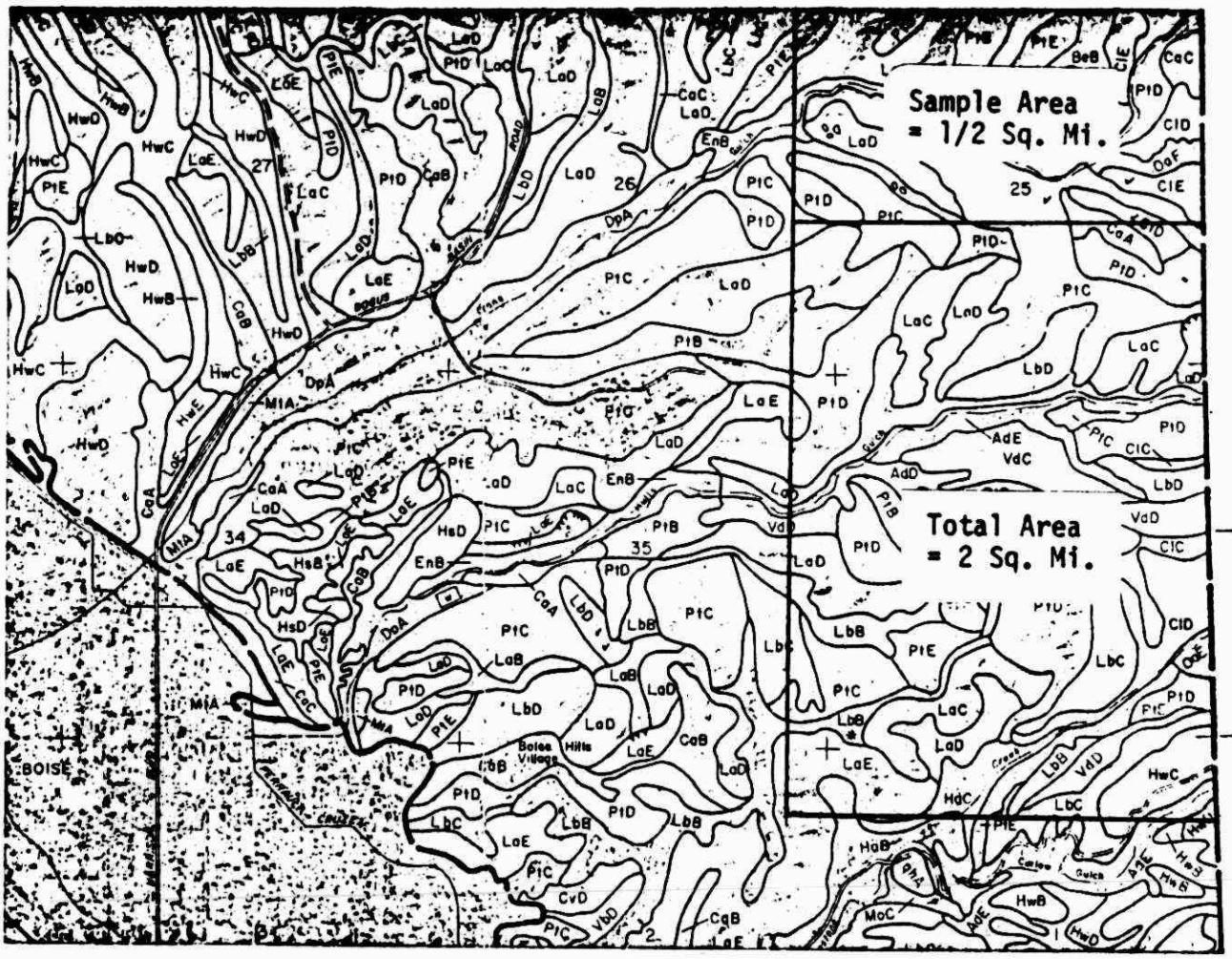


Figure 3. Soil Map

A transparency showing soil types can be made to overlay aerial mosaics. Soil types can be associated with land use by this method.

The program does not require the user to code every soil type in the basin study area. One or more sample areas can be selected and coded

and the program will "scale up" the soil erosion variables to include the entire study area. For example, the soil types, columns (1) and (4) in Table 3, were coded from the 1/2 square mile sample area shown on Fig. 3.

Table 3. Sampling Soil Types in a Study Area

Soil Type	No. of Grid Points (sample)	% of Study Area	Soil Type	No. of Grid Points (sample)	% of Study Area
(1)	(2)	(3)	(4)	(5)	(6)
LbC	3	.7	BeB	7	1.7
CaC	3	.7	PtE	5	1.2
PtD	6	1.4	PtB	5	1.2
CiD	4	1.0	LaD	17	4.0
DaT	4	1.0	PtB	2	.5
CiE	4	1.0	LaD	6	1.4
CiE	5	1.2	EnB	4	1.0
CiD	12	2.9	PtD	3	.7
PtC	12	2.9	PtC	2	.5
			TOTAL	104	25.0

A grid sampling technique was used in which a 1/2 square mile grid has 104 points. The numbers of points in various soil groups in the sample are shown in columns (2) and (5). The percent of the total 2 square mile study area is calculated by dividing the number of points for each soil type by the number of grid points in the total study area (416).

If one sample is not adequate to describe an entire study area, several representative samples may be taken.

(3) Erosion During and After Construction.

When evaluating the impact of a development on land surface erosion from the area, L, S, C and P may be specified for each land use. The soil type codes are used again to identify the soil types in each land use category. The program will then calculate erosion rate, erosion, and washoff of dust and dirt from impervious areas either for a single storm or for a period of record of events. By varying C and P one can calculate erosion during construction or during some other phase of land management.

By comparing these results with that from natural conditions, the increase or decrease in land surface erosion due to ultimate development or the interim construction practice can be estimated.

(4) Erosion by Land Use.

One must specify the variables for equation (23) for each land use. It is difficult to select one average value when there are so many different soil types; therefore, the capability of specifying each set of soil and erosion control properties as a percent of the total area for that land use is provided. The program weights and combines these distributed properties into one representative value for that land use called "potential soil erosion factor."

Each land use may be sampled independently from all others. There is no program limit to the number of samples or the number of soil types. Some samples may account for 100 percent of the land in their land use category while others in the same data set do not.

(5) Sediment Delivery Ratio (SDR)

The soil erosion equation (23) predicts the erosion rate at the point where soil leaves that plot of ground (i.e., land use category). Other factors are important in determining how much of that sediment reaches the outflow point of the watershed being analyzed. Sediment will deposit in the surface and subsurface conveyance systems, streets, sediment traps and on other land uses. The size of sediment particles, flow depth, and flow velocity are among the important factors. This program lumps all of these into one constant called the "Sediment Delivery Ratio."

The Sediment Delivery Ratio is an empirical coefficient. It replaces all of the complex equations required to model sediment transport in conveyance systems plus the even less understood movement of sediment-laden overland flow beyond the land use category being analyzed. Values are needed for urban as well as nonurban land uses. Therefore, it must be calibrated for each watershed.

Using Figure 4 and soil types from Table 3, the suggested procedure for coding erosion variables by land use is as follows:

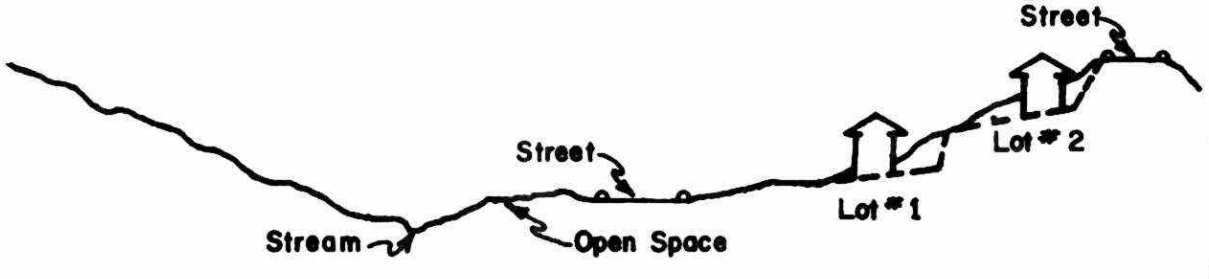


Fig. 4
Cross Section of Natural Terrain
and Proposed Construction

Table 4. Coding Erosion Variables

Land Use	Soil Type Code	Soil Type Percent of this Land Use	Length ft.	Slope %	C %	P %	K —	SDR —
OPEN	LbC	100	*	*	*	*	*	1.0
SINGLE	CaC	50	110	-3	1	*	*	.95
SINGLE	PtD	50	110	3	1	*	*	.7

*Consult SCS personnel for appropriate values.

This example assumes a fully developed condition. The OPEN space is assumed to be in soil type LbC which makes up 100% of the "OPEN" land use. Its length and P default, K is defined by knowing LbC. C is assumed to be 2%. Since the area drains into a stream, the SDR (sediment delivery ratio) is assumed to be 1.

Single unit residences in Figure 4 drain into a street or onto a neighbor's yard. A negative slope indicates drainage onto a street or other impervious area. This is assigned a SDR of .95. For SINGLE units which drain away from the street, a SDR of 0.7 was calculated from the LS equation as follows:

for 1 lot length L = 110', s = 3% LS = $\sqrt{L}(.03034) = .32$

for 2 lot lengths L = 220', s = 3% LS = $\sqrt{2L}(.03034) = .45$

SDR = $.32/.45 = .7$

As the user becomes more familiar with the map scales and use of this procedure, he will probably reduce the amount of detail in sampling and use, instead, more judgment.

(5) Program Operation

a. Computational Procedure

A summary of the computational procedure is shown in Figure 5. Some of the computations may be bypassed depending upon the program options specified. The first block of Figure 5 where "basic data" are read includes information on

Job specifications,

Hourly precipitation record,] available on magnetic tape from the National Weather Service

Daily temperature record,]

Land use data including runoff parameters,

Pollutant accumulation and washoff data, and

Land surface erosion data.

The entire rainfall/snowmelt record is processed for each storage/treatment alternative as shown in Figure 5.

b. I/O Unit Assignments and Program Specifications

The program requires a minimum of one tape/disk unit if rainfall is read from cards and only the quantity output report is generated. The following unit assignments are necessary for the indicated options.

FORTRAN Logical Unit	Option
IN (Input variable)	Input precipitation record from tape/disk "IN"
ITAPE (Input variable)	Input temperature record from tape/disk "ITAPE"
11	Working storage for snowmelt computation
12	Working storage for precipitation record
13	Output file for Quality Report
14	Output file for Pollutograph Report
15	Output file for Sediment Report

Figure 5. Computational Procedure Flow Chart

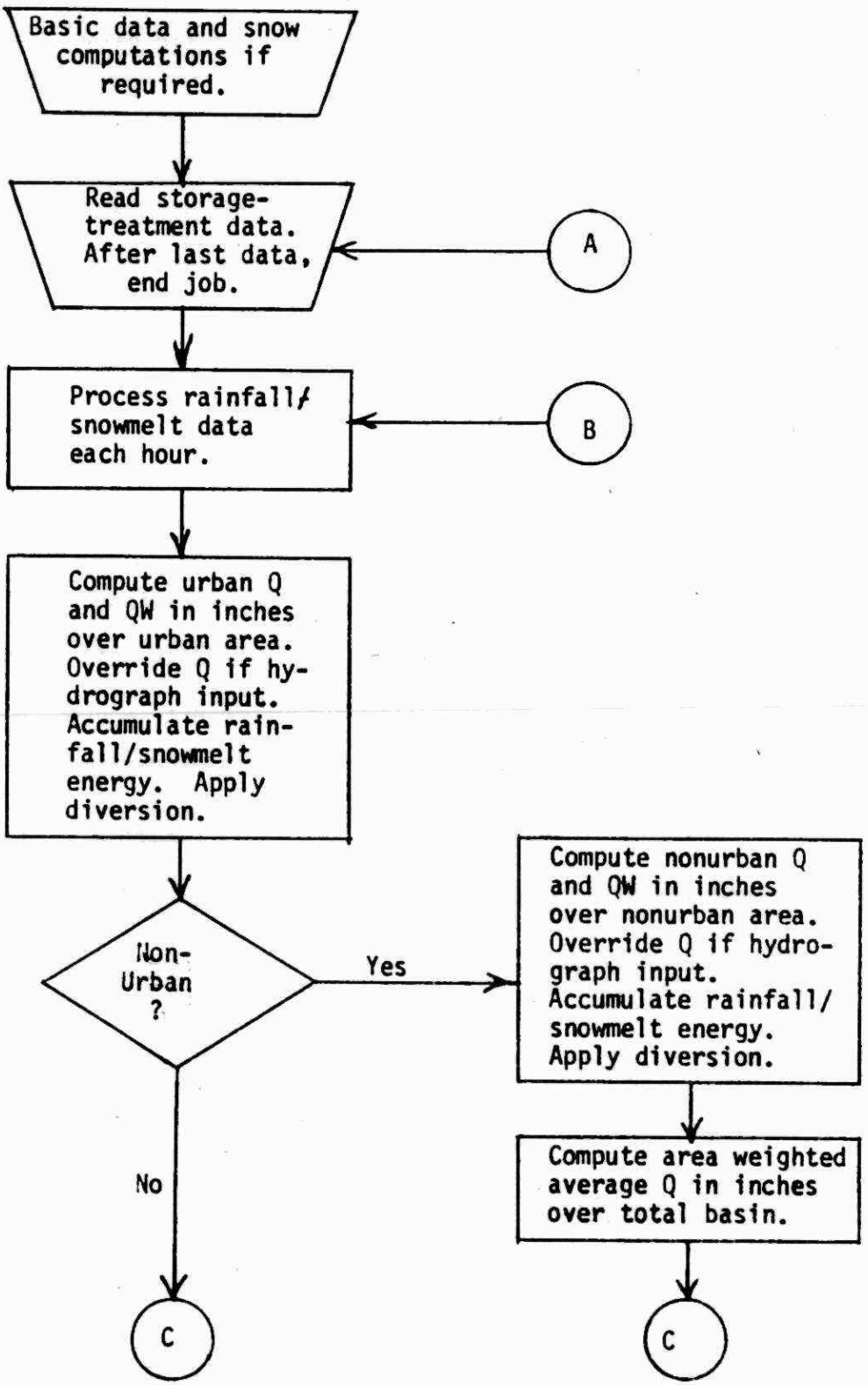
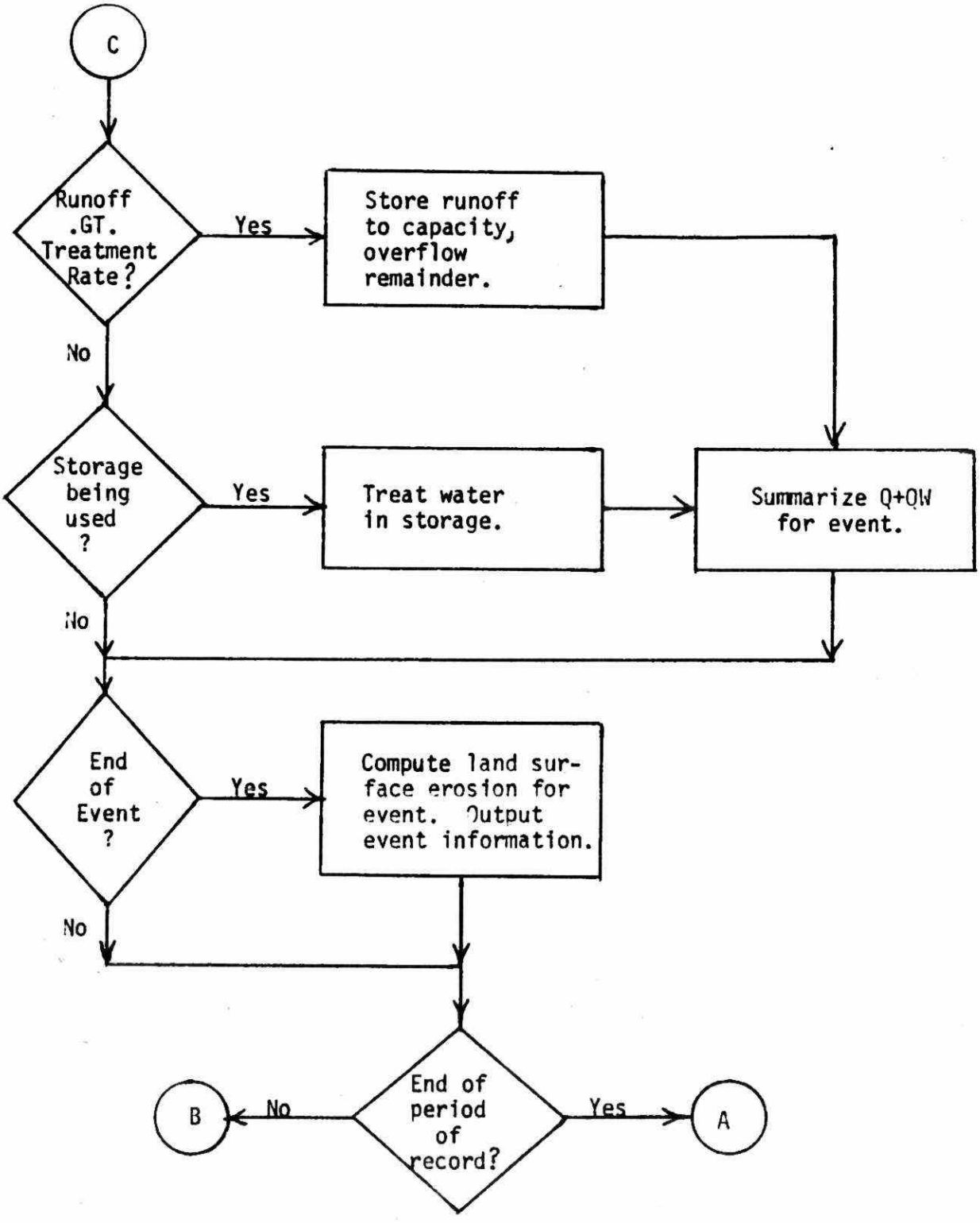

Basic data and snow computations if required.
Read storage-treatment data. After last data, end job.
A
Process rainfall/ snowmelt data each hour.
B
Compute urban Q and QW in inches over urban area. Override Q if hydrograph input. Accumulate rainfall/snowmelt energy. Apply diversion.
Non-Urban ?
Yes
No
Compute nonurban Q and QW in inches over nonurban area. Override Q if hydrograph input. Accumulate rainfall/ snowmelt energy. Apply diversion.
Compute area weighted average Q in inches over total basin.
C
C

Fig. 5 (cont.)


C
Runoff .GT. Treatment Rate?
Yes
Store runoff to capacity, overflow remainder.
No
Storage being used ?
Yes
Treat water in storage.
Summarize Q+QW for event.
No
End of Event ?
Yes
Compute land surface erosion for event. Output event information.
No
End of period of record?
No
B
Yes
A

It is only necessary to use a maximum of four tape/disk units at one time. The snowmelt computations need not be recomputed for each job. Once the snowmelt computations are satisfactory, the working tape/disk on unit 12 can be saved for future jobs. The input data then specifies this direct input on unit 12 and units IN, ITAPE, and 11 are not necessary. The Input Description, Exhibit 3 describes the variables necessary to accomplish these tape/disk options.

In addition to the tape/disk units previously mentioned, the program uses the card reader and a 132 position line printer. Some other specifications of the program operation are shown below.

	UNIVAC 1108	CDC 7600
Core storage, words	40,000	40,000
Compilation time, CPU seconds	35	3
Execution of Test 1, CPU seconds	14	2
Execution of Test 2, CPU seconds	17	3

c. Model Usage

The STORM program can be used for a number of different studies in urban areas. Three major applications are:

Storage/Treatment analysis for runoff from an urban area;

Quantity and quality contributions from an urban and/or nonurban area for input to a system model; and

Analysis of land use management on individual parcels of land.

Before the model can be used in these analyses, the model parameters must be calibrated to observed quantity, quality and erosion data. Calibration may be accomplished by running the zero storage/zero treatment alternative where all rainfall excesses and runoff are shown. From

this output the monthly volumes of runoff can be summarized and compared with historical runoff. This comparison will assist parameter adjustment for the long term water balance. Pollutographs may be requested for selected events and further calibration made to reproduce hourly runoff volumes or pollutant loadings.

(6) Input Structure

A detailed description of the STORM input data is given in Exhibit 3. The data are on punched cards and tape/disk as indicated by the input options. The input data for two test problems are shown in Exhibits 1 and 2.

(7) Output

The STORM program produces four output reports. They are

Quantity Analysis;

Quality Analysis;

Pollutograph Analysis; and

Land Surface Erosion Analysis.

The quantity analysis report is generated directly on the line printer as the program executes. The other three reports are generated concurrently on tape/disk for later printing at the end of the job. Input variables allow control of the level of printout which may be summary only, all events, and/or detailed analysis of selected events. The quantity and quality reports also include average annual statistics of the rainfall/snowmelt,

runoff, pollutant washoff and the quantity, quality and frequency of overflows to the receiving water. The land surface erosion report shows average annual values for sediment production and delivery to the receiving system.

Test problems 1 and 2 in Exhibits 1 and 2 illustrate some of the various forms of the output. The column headings for the quantity report are described in detail by a program generated table of definitions following the report. The column headings for the other three reports are self-explanatory.

(8) REFERENCES

a. American Public Works Association, "Water Pollution Aspects of Urban Runoff," Water Pollution Control Research Series, Federal Water Pollution Control Administration, Report No. WP-20-15, January 1969.

b. Metcalf & Eddy, Inc., University of Florida and Water Resources Engineers, Inc., "Storm Water Management Model," Water Pollution Control Research Series, Environmental Protection Agency, Report No. 11024DOC07/71, Volume I, Final Report, July 1971.

c. "Rainfall - Erosion Losses from Cropland East of the Rocky Mountains," Agriculture Handbook No. 282, Government Printing Office, Washington, DC, 1965.

d. "Soil Survey and Interpretations for the Boise Front," Ada County, Idaho, U.S. Dept. of Agriculture, Soil Conservation Service, Meridian, Idaho, 1972.

e. Wischmeier, Walter H. and Dwight D. Smith, "Rainfall Energy and Its Relationship to Soil Loss," Transactions, American Geophysical Union, Vol. 39, No. 2, April 1958.

f. Brandt, G. H. and others, "An Economic Analysis of Erosion and Sediment Control Measures for Watersheds Undergoing Urbanization," The Dow Chemical Company, Contract No. 14-31-0001-3392, Feb. 1972, p. 85.

Exhibit 1: Test Problem #1

Test problem #1 incorporates the following analyses using the STORM program.

Quantity and quality of runoff from a multi-land use urban watershed,

Rainfall only as precipitation input,

Calibration,

Storage/Treatment analysis, and

Pollutographs for selected events.

The following pages of this exhibit show the input data and the corresponding program output for the above analyses.

Calibration of the model parameters is accomplished through the use of the zero storage/zero treatment alternative. Under this alternative, the rainfall excess is not altered by storage or treatment so that a detailed comparison of computed and observed pollutographs can be made for selected storms. Further calibration can be accomplished by comparing computed and observed quality and quantity of runoff for any duration (e.g., monthly, yearly, etc).

The zero storage/zero treatment alternative is also used to predict the quantity and quality of runoff from uncontrolled areas. The predicted runoff may be used to compare the effects of different land use development schemes.

The nonzero storage/treatment analysis is used to aid in sizing storage/treatment facilities. The procedure is to compare the frequency, quantity and quality of system overflows for various storage/treatment

alternatives. This information along with the costs of the facilities can lead to a least cost solution for a particular degree of acceptable overflow quantity and quality.

TEST 1 INPUT DATA

```
A1       TEST 1                                    STORM                                    L2520
A2  RAINFALL RUNOFF STORAGE/TREATMENT ANALYSIS FOR AN URBAN AREA, NO SEDIMENT
A3     DAVISVILLE, CALIFORNIA                                    EXHIBIT ONE
B1     1        0        0        0        1        1
B2   120        3        0
C1  YOLO INTERNATIONAL AIRPORT          5                                                1
C 721115                                                  5  8 22 14 15 34 28  3  1 15
C 721117                                                    16
C 721118                                      1  2
C 721119  4  1                   10 15
C 721203                                                    5  1  1        3
C 721204                          2  3
C 721205  2 14  5 13  6  5                    5        3                    7           4
C 721207  3        2  3                       7     2     1
C 721216                                                    3  4  1  2  3  2     1  1  6
C 721217  5        4  5  3
C 721218                                                                       15 20 11 14
C 721219  3  3
C 721222           10
C 721223                                                                                5
C 721227                                                          5  5
C 730108                          2  5  3  6  3  3  8  2        16 17 23  2           3  2 10
C 730109  5  3  1     2  4 10 20 11  2 14  4  1  4  9  4  1
C 730111                          1  5  4  7  1  2 12 20 17.11  4     4
C 730112                    3 13 19  4  7  4
C 730116                   20 19 31 30 15  8 14        1  2                          11  2  3
C 730117  4                                                                    10 10 16 19  8
C 730118  7                         6 39 14 16 18 15  2
C 730121  4  6  4  3  4
C 730124                                                                                6  4  5
C 730125                                  3  4  3
C 730129                    7  9  3                          4 16  1  3  3  1  3
C 730130     1  2  3
C 730131        4  2
C 730203                                        3  7  2           6  5  1  1
C 730204                          1  1     1
C 730205                                                                          9  3
C 730206                          3  2  5  7 23 21 27 12  3  3  8  1     2  3
C 730209                                                    7  3  2  6        9 29  7
C 730210                                                 2        3     2  6  7
C 730211                                  2  3                    4  5     1  5  8     2
C 730212                                                    2  3  1  3  3     8  5  3  2  4  5
C 730213  5  1  5
C 730214                    2  4  7  6  1    17  3
C 730227                                  8 11  7  6  8 15 36                 3 12  2        3
C 730303                                  8  7 10  5 18  2     5                          4
C 730306                       4 28  4  4  7
C2
E1       CORE AREA        4       4.6       .7
E2  3156      .15      .90      1.0
E3    .10     .23      .36      .69      .95    1.16    1.29    1.29    1.28     .98
E3    .59     .40      .25
F1SINGLE       70       40      275       60
F2
F1MULTPL        3       50      430       60
```

```
F1COMMCL        7       50      100     100
F2   5.7     21.2      2.3      .95     .055    .009
F1OPEN         20        0       20      100
F2
T1      2
T2    .00       1       2        0        3
T3    .00
T4      1       7
T2    .05       1       3        1        3
T3    .10
T4      1       2       3
```

STORM, L2520, VERSION DATED MAY 1974, UPDATED AUG 74
****

TEST 1 PROGRAM OUTPUT

TEST 1 STORM L2520
RAINFALL RUNOFF STORAGE/TREATMENT ANALYSIS FOR AN URBAN AREA, NO SEDIMENT
DAVISVILLE, CALIFORNIA EXHIBIT ONE

NWSHD	ISNO	NONURB	ISED	IQUAL	IEVNT
1	0	0	0	1	1

NSUMR	LEXT	LINE	LDATE	LHR
120	3	0	-6	-0

TITLE OF RAIN GAGE
YOLO INTERNATIONAL AIRPORT

IN	IFILE	ISTART	IEND	IR
5	-0	-0	999999	1

RAINFALL DATA FOR YOLO INTERNATIONAL AIRPORT
HOURLY RAINFALL, IN HUNDRETHS OF AN INCH

YEAR	MO	DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1972	11	15	0	0	0	0	0	0	0	0	0	0	0	0	5	8	22	14	15	34	28	3	1	15	0	0	145
1972	11	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	16
1972	11	18	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3
1972	11	19	4	1	0	0	0	0	0	10	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
1972	12	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1	1	0	0	3	0	0	0	0	10
1972	12	4	0	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
1972	12	6	2	14	5	13	6	5	0	0	0	0	5	0	0	3	0	0	0	0	0	7	0	0	0	4	64
1972	12	7	3	0	0	2	3	0	0	0	0	0	7	0	2	0	1	0	0	0	0	0	0	0	0	0	18
1972	12	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	1	2	3	2	0	1	1	6	23
1972	12	17	5	0	0	4	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
1972	12	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	20	11	14	60
1972	12	19	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
1972	12	22	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
1972	12	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5
1972	12	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	10
1973	1	8	0	0	0	0	2	5	3	6	3	3	8	2	0	0	16	17	23	2	0	0	0	3	2	10	105
1973	1	9	5	3	1	0	2	4	10	20	11	2	14	4	1	4	9	4	1	0	0	0	0	0	0	0	95
1973	1	11	0	0	0	0	0	0	1	5	4	7	1	2	12	20	17	11	4	0	4	0	0	0	0	0	88
1973	1	12	0	0	0	3	13	19	4	7	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50
1973	1	16	0	0	0	20	19	31	30	15	8	14	0	0	1	2	0	0	0	0	0	0	11	2	3	0	156
1973	1	17	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	16	19	8	72
1973	1	18	7	0	0	0	0	0	6	39	14	16	18	15	2	0	0	0	0	0	0	0	0	0	0	0	117
1973	1	21	4	8	4	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23
1973	1	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	5	15
1973	1	25	0	0	0	0	0	0	0	3	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
1973	1	29	0	0	0	7	9	3	0	0	0	0	0	0	0	0	0	0	4	16	1	3	3	1	3	0	50
1973	1	30	0	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
1973	1	31	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
1973	2	3	0	0	0	0	0	0	0	0	0	3	7	2	0	0	0	6	5	1	1	0	0	0	0	0	25
1973	2	4	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
1973	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	3	0	0	12
1973	2	6	0	0	0	0	3	2	5	7	23	21	27	12	3	3	8	1	0	2	3	0	0	0	0	0	120
1973	2	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	3	2	8	0	0	9	29	7	0	65
1973	2	10	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	3	0	2	6	7	0	0	0	0	20
1973	2	11	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	4	5	0	1	5	8	0	2	30
1973	2	12	0	0	0	0	0	0	0	0	0	0	0	0	2	3	1	3	3	0	8	5	3	2	4	5	39
1973	2	13	5	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
1973	2	14	0	0	2	4	7	6	1	0	17	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40
1973	2	27	0	0	0	0	0	0	0	8	11	7	6	8	15	36	0	0	0	0	3	12	2	0	0	3	111
1973	3	3	0	0	0	0	0	0	0	8	7	10	5	18	2	0	5	0	0	0	0	0	0	4	0	0	59
1973	3	6	0	0	0	0	0	4	28	4	4	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47

END OF RAINFALL DATA,
41 RAINFALL DAYS PROCESSED ENCOMPASSING 117 DAYS (1 YEARS) OF RECORD,

URBAN WATERSHED DATA

NAME	MXLG	EXPTE	REFF
CORE AREA	4	4.600	.700

AREA	CPERV	CIMP	RFU	IQU	DVU	DVUMX	WU
3136.00	.15	.90	1.00	-0	-0.00	-0.00	-0.00

DEPRESSION STORAGE (INCHES)	DAILY EVAPORATION RATES FOR EACH MONTH, JAN-DEC IN INCHES/DAY											
.100	.23	.36	.69	.95	1.16	1.29	1.29	1.28	.98	.59	.40	.25

INPUT DATA DESCRIBING LAND USE AND POLLUTANTS

LNDUSE	PRCNT	FIMP	STLEN	NCLEAN	DD	POUNDS POLLUTANT PER 100LB DD				
						SUSP	SETL	BOD	N	PO4
SINGLE	70.0	40.0	275.0	60	-0.00	-0.000	-0.000	-0.000	-0.000	-0.000
MULTPL	3.0	50.0	430.0	60	-0.00	-0.000	-0.000	-0.000	-0.000	-0.000
COMMCL	7.0	50.0	100.0	100	5.70	21.200	2.300	.950	.055	.009
OPEN	20.0	0.0	20.0	100	-0.00	-0.000	-0.000	-0.000	-0.000	-0.000

COMPUTED RUNOFF COEFFICIENT FOR WATERSHED IS .39750

FRACTION OF URBAN WATERSHED THAT IS IMPERVIOUS IS .3300

LAND USE AND POLLUTANT DATA WITH DEFAULT VALUES ADDED

LAND USE	PRCNT OF LND AREA	PRCNT IMPERV	GUTTERS FT/AC	SWEEPING INTRVL, DYS	DD RATE LBS/DAY	********** LBS POLLUTANT/100LBS DD **********				
						SUSP	SETL	BOD	N	PO4
SINGLE	70.0	40.0	275.0	60	4225.8	11.100	1.100	.500	.048	.005
MULTPL	3.0	50.0	430.0	60	930.5	8.000	.800	.360	.061	.005
COMMCL	7.0	50.0	100.0	100	1251.3	21.200	2.300	.950	.055	.009
OPEN	20.0	0.0	20.0	100	188.2	11.100	1.100	.500	.048	.005

2 TREATMENT RATE(S) WILL BE INVESTIGATED

TREATMENT RATE (IN/HR)	NO. OF STORAGES	NO. OF POLLUTOGRAPHS	PLOT	PRINT	IPRTS	IEROMX
0.0000	1	2	0	3	-0	-0

STORAGES TO BE USED WITH ABOVE TREATMENT RATE (INCHES) 0.000

STORM POLLUTOGRAPHS WILL BE PRINTED FOR THESE EVENTS: 1 7

DAVISVILLE, CALIFORNIA — EXHIBIT ONE

QUANTITY ANALYSIS

YOLO INTERNATIONAL AIRPORT
CORE AREA

TREATMENT RATE = .0000 IN/HR, 0.0 CFS, 0.000 MGD
STORAGE CAPACITY= .0000 INCHES, .0 AC-FT, .000 MG

EVENT	YEAR	MO	DY	HR	STORAG	DURTN	HRS	QUANTITY	RUNOFF INCHES	HRS TO EMPTY	STORAGE DURTN	STORAGE MAX	OVERFLOW NO	OVERFLOW ST	OVERFLOW DUR	WASTE	INITL	TREATMENT HRS	TREATMENT QANTY	AGE1	AGE2	AGE3	AGE4	AGE5
1	72	11	15	14	156	9	9	1.40	.58	1	10	0.00	1	1	9	.53	.15	10	0.00	.5	8.5	8.5	8.5	8.5
2	72	11	17	15	39	1	1	.10	.02	1	2	0.00	2	1	1	.02	.02	2	0.00	.5	.5	.5	.5	.5
3	72	11	19	9	40	1	1	.15	.06	1	2	0.00	3	1	1	.05	.05	2	0.00	.5	.5	.5	.5	.5
4	72	12	6	2	399	5	5	.43	.14	1	6	0.00	4	1	5	.13	.09	6	0.00	.5	4.5	4.5	2.5	2.5
5	72	12	6	11	3	1	1	.15	.00	1	2	0.00	5	1	1	0.00	0.00	2	0.00	.5	.5	.5	.5	.5
6	72	12	6	14	1	1	1	.03	.00	1	2	0.00	6	1	1	0.00	0.00	2	0.00	.5	.5	.5	.5	.5
7	72	12	6	20	4	1	1	.07	.01	1	2	0.00	7	1	1	0.00	0.00	2	0.00	.5	.5	.5	.5	.5
8	72	12	6	24	2	2	2	.07	.02	1	3	0.00	8	1	2	.01	.01	3	0.00	.5	1.5	1.5	1.0	1.0
9	72	12	7	5	2	1	1	.03	.01	1	2	0.00	9	1	1	.01	.01	2	0.00	.5	.5	.5	.5	.5
10	72	12	7	11	4	3	2	.14	.01	1	4	0.00	10	1	2	.01	.01	4	0.00	.6	.5	.5	.5	.5
11	72	12	16	19	220	2	2	.75	.02	1	3	0.00	11	1	2	.01	.01	3	0.00	.5	1.5	1.5	1.0	1.0
12	72	12	16	23	1	3	3	.12	.05	1	4	0.00	12	1	3	.04	.04	4	0.00	.5	2.5	2.5	1.5	1.5
13	72	12	17	4	1	3	3	.12	.04	1	4	0.00	13	1	3	.03	.03	4	0.00	.5	2.5	2.5	1.5	1.5
14	72	12	18	21	37	6	6	.66	.22	1	7	0.00	14	1	6	.22	.18	7	0.00	.5	5.5	5.5	3.0	3.0
15	73	1	8	8	464	5	5	.22	.09	1	6	0.00	15	1	5	.08	.08	6	0.00	.5	4.5	4.5	2.5	2.5
16	73	1	8	15	1	4	4	.58	.22	1	5	0.00	16	1	4	.22	.21	5	0.00	.5	3.5	3.5	2.0	2.0
17	73	1	8	22	2	20	19	1.10	.42	1	21	0.00	17	1	19	.42	.04	21	0.00	.6	12.5	12.5	5.4	5.4
18	73	1	11	13	39	10	9	.78	.31	1	11	0.00	18	1	9	.30	.03	11	0.00	.9	7.5	7.5	3.6	3.6
19	73	1	12	5	8	5	5	.47	.17	1	6	0.00	19	1	5	.14	.12	6	0.00	.5	4.5	4.5	2.5	2.5
20	73	1	16	4	89	7	7	1.37	.50	1	8	0.00	20	1	7	.50	.23	8	0.00	.5	6.5	6.5	3.5	3.5
21	73	1	16	14	2	1	1	.02	.00	1	2	0.00	21	1	1	0.00	0.00	2	0.00	.5	.5	.5	.5	.5
22	73	1	16	21	5	5	4	.25	.07	1	6	0.00	22	1	4	.07	.04	6	0.00	.8	2.5	2.5	1.3	1.3
23	73	1	17	21	18	5	5	.60	.24	1	6	0.00	23	1	5	.23	.17	6	0.00	.5	4.5	4.5	2.5	2.5
24	73	1	18	7	4	7	7	1.10	.42	1	8	0.00	24	1	7	.41	.21	8	0.00	.5	6.5	6.5	3.5	3.5
25	73	1	21	2	59	4	4	.19	.05	1	5	0.00	25	1	4	.05	.03	5	0.00	.5	3.5	3.5	2.0	2.0
26	73	1	24	24	89	1	1	.05	.02	1	2	0.00	26	1	1	.01	.01	2	0.00	.5	.5	.5	.5	.5
27	73	1	25	4	7	2	2	.07	.01	1	3	0.00	27	1	2	.01	.01	3	0.00	.5	1.5	1.5	1.0	1.0
28	73	1	29	5	89	2	2	.12	.04	1	3	0.00	28	1	2	.03	.03	3	0.00	.5	1.5	1.5	1.0	1.0
29	73	1	29	16	10	6	6	.27	.09	1	7	0.00	29	1	6	.08	.05	7	0.00	.5	5.5	5.5	3.0	3.0
30	73	1	30	3	2	2	2	.05	.02	1	3	0.00	30	1	2	.01	.01	3	0.00	.5	1.5	1.5	1.0	1.0
31	73	2	3	12	102	1	1	.02	.01	1	2	0.00	31	1	1	0.00	0.00	2	0.00	.5	.5	.5	.5	.5
32	73	2	3	16	2	4	4	.13	.03	1	5	0.00	32	1	4	.03	.02	5	0.00	.5	3.5	3.5	2.0	2.0
33	73	2	5	22	49	1	1	.03	.01	1	2	0.00	33	1	1	0.00	0.00	2	0.00	.5	.5	.5	.5	.5
34	73	2	6	7	7	13	12	1.15	.44	1	14	0.00	34	1	12	.43	.12	14	0.00	.9	9.5	9.5	4.3	4.3
35	73	2	9	17	68	2	2	.10	.04	1	3	0.00	35	1	2	.03	.03	3	0.00	.5	1.5	1.5	1.0	1.0
36	73	2	9	21	1	3	3	.15	.17	1	4	0.00	36	1	3	.16	.16	4	0.00	.5	2.5	2.5	1.5	1.5
37	73	2	10	20	19	1	1	.07	.03	1	2	0.00	37	1	1	.02	.02	2	0.00	.5	.5	.5	.5	.5
38	73	2	11	21	23	4	3	.15	.05	1	5	0.00	38	1	3	.04	.04	5	0.00	.7	1.5	1.5	.8	.8
39	73	2	12	17	15	11	10	.41	.15	1	12	0.00	39	1	10	.15	.05	12	0.00	.5	8.5	8.5	4.1	4.1
40	73	2	14	5	24	6	5	.38	.11	1	7	0.00	40	1	5	.11	.03	7	0.00	.7	2.5	2.5	1.3	1.3
41	73	2	27	9	309	6	6	.83	.32	1	7	0.00	41	1	6	.32	.08	7	0.00	.5	5.5	5.5	3.0	3.0
42	73	2	27	20	4	2	2	.13	.04	1	3	0.00	42	1	2	.04	.04	3	0.00	.5	1.5	1.5	1.0	1.0
43	73	3	3	9	62	7	6	.47	.17	1	8	0.00	43	1	6	.16	.07	8	0.00	.6	4.5	4.5	2.2	2.2
44	73	3	6	7	62	4	4	.43	.15	1	5	0.00	44	1	4	.14	.11	5	0.00	.5	3.5	3.5	2.0	2.0
AVE OF	44	EVENTS			59.7**	4.3	4.1	.35	.13	1.0	5.3	.00		0.0*				5.3	.00	.5	3.3	3.3	1.8	1.8
AVE OF	44	OVRFLW	EVENTS		4.3	4.1	.35	.13	1.0	5.3	0.00*		1.0	4.1	.13	.06		5.3	.00	.5	3.3	3.3	1.8	1.8

* NON-OVERFLOW EVENTS ONLY.
**EXCLUDING 0 DRY PERIODS

NUMBER OF EVENTS = 44.0

NUMBER OF OVERFLOWS = 44.0

	INCHES	
TOTAL PRECIPITATION ON WATERSHED	17.97	
TOTAL RUNOFF FROM WATERSHED	5.52	FRACTION OF RAINFALL = .31
OVERFLOW TO RECEIVING WATER	5.52	FRACTION OF RAINFALL = .31, OF RUNOFF =1.00
INITIAL OVERFLOW TO RECIEVING WATER	2.84	FRACTION OF RAINFALL = .16, OF RUNOFF = .51

TREATMENT RATE (IN/HR)	NO. OF STORAGES	NO. OF POLLUTOGRAPHS	PLOT	PRINT	IPRTS	IERDMX
.0500	1	3	1	3	=0	=0

STORAGES TO BE USED WITH ABOVE TREATMENT RATE (INCHES) .100

STORM POLLUTOGRAPHS WILL BE PRINTED FOR THESE EVENTS: 1 2 3

DAVISVILLE, CALIFORNIA — EXHIBIT GUE

QUANTITY ANALYSIS

YOLO INTERNATIONAL AIRPORT
CORE AREA

TREATMENT RATE = .0500 IN/HR, 158.1 CFS, 102.187 MGD
STORAGE CAPACITY= .1000 INCHES, 26.1 AC-FT, 8.517 MG

EVENT	YEAR	MO	DY	HR	STORAG	DURTN	HRS	QUANTY	RUNOFF INCHES	HRS TO EMPTY	DURTN	MAX	NO	ST	DUR	WASTE	INITL	HRS	QUANTY	AGE1	AGE2	AGE3	AGE4	AGE5
1	72	11	15	15	157	8	8	1.32	.52	1	9	.10	1	4	2	.09	.09	10	.43	1.1	3.5	6.5	2.2	2.7
2	72	11	19	9	81	1	1	.15	.06	1	2	0.00		1	NO OVERFLOW			3	.08	.5	.5	.5	.5	.5
3	72	12	0	4	401	2	2	.19	.08	0	2	0.00		1	NO OVERFLOW			5	.13	.5	.5	.5	.5	.5
4	72	12	18	22	309	4	4	.48	.19	0	4	.02		1	NO OVERFLOW			22	.38	.5	2.1	2.1	1.4	1.4
5	73	1	8	15	493	8	8	.98	.22	1	5	.06		3	NO OVERFLOW			10	.31	.7	1.5	2.0	1.0	1.2
6	73	1	9	8	12	5	5	.51	.20	0	5	.02		1	NO OVERFLOW			15	.35	.7	1.5	1.5	.9	.9
7	73	1	11	14	49	4	4	.52	.21	1	5	.04		2	NO OVERFLOW			14	.37	.9	2.5	3.5	1.4	1.5
8	73	1	12	6	11	2	2	.23	.09	0	2	.02		1	NO OVERFLOW			4	.15	.6	.5	.5	.5	.5
9	73	1	16	5	93	6	6	1.17	.47	2	8	.10	2	3	2	.07	.07	10	.44	1.3	4.9	6.2	2.6	2.8
10	73	1	17	22	33	4	4	.50	.20	0	4	.03		2	NO OVERFLOW			10	.31	.6	1.5	2.1	1.0	1.2
11	73	1	18	8	8	6	6	1.04	.41	2	8	.10	3	1	5	.05	.02	9	.36	1.6	6.5	6.5	2.9	2.9
12	73	2	6	9	849	8	8	.98	.39	0	8	.10	4	3	1	.03	.03	33	.66	1.3	4.5	6.5	2.0	2.3
13	73	2	9	22	77	2	2	.36	.14	1	3	.06		1	NO OVERFLOW			8	.22	.6	1.5	1.5	.9	.9
14	73	2	14	9	104	2	2	.20	.07	0	2	.01		1	NO OVERFLOW			19	.33	.5	.5	.5	.5	.5
15	73	2	27	13	314	2	2	.41	.20	2	4	.10	5	2	1	0.00	0.00	8	.31	1.6	1.5	1.7	.9	.9
16	73	3	3	12	91	2	2	.20	.08	0	2	.02		1	NO OVERFLOW			7	.20	.5	.5	.5	.5	.5
17	73	3	6	7	65	3	3	.36	.12	0	3	.03		1	NO OVERFLOW			5	.15	.7	1.5	1.5	.6	.6
AVE OF	17	EVENTS			161.2**	3.8	3.8	.55	.22	.6	4.5	.05		1.3*				11.3	.31	.8	2.1	2.6	1.2	1.3
AVE OF	5	OVRFLW	EVENTS			6.0	6.0	1.10	.40	1.4	7.8	.03*		2.6	2.2	.05	.05	14.0	.44	1.3	4.2	5.5	2.1	2.3

* NON-OVERFLOW EVENTS ONLY.
**EXCLUDING 0 DRY PERIODS

AVERAGE ANNUAL STATISTICS FOR 1 YEARS OF RECORD FOR THE PERIOD BEGINNING 721115 AND ENDING 730306

NUMBER OF EVENTS = 17.0

NUMBER OF OVERFLOWS = 5.0

	INCHES	
TOTAL PRECIPITATION ON WATERSHED	17.97	
TOTAL RUNOFF FROM WATERSHED	5.52	FRACTION OF RAINFALL = .31
OVERFLOW TO RECEIVING WATER	.27	FRACTION OF RAINFALL = .01, OF RUNOFF = .05
INITIAL OVERFLOW TO RECIEVING WATER	.24	FRACTION OF RAINFALL = .01, OF RUNOFF = .04

DAVISVILLE, CALIFORNIA

QUANTITY ANALYSIS

EXHIBIT ONE

TREATMENT RATE = .0500 IN/HR, 158.1 CFS, 102.187 MGD
STORAGE CAPACITY= .1000 INCHES, 20.1 AC-FT, 6.517 MG

AVERAGE ANNUAL STORAGE REQUIRED AT EACH HOUR OF THE EVENT (INCHES).

.560	.720	.630	.680	.380	.250	.080	.060	.010

AVERAGE ANNUAL NUMBER OF HOURS EACH MO D-ETH OF AN EACH OF STORAGE WAS UTILIZED.

27,000	3,000	14,000	4,000	5,000	4,000	3,000	1,000	2,000	13,000

PERCENTAGE OF TIME LESS THAN OR EQUAL TO EACH STORAGE AMOUNT, IN PERCENT OF CAPACITY.

10	36	20	39	30	56	40	63	50	70	60	75	70	79	80	80	90	83	100	100

DAVISVILLE, CALIFORNIA

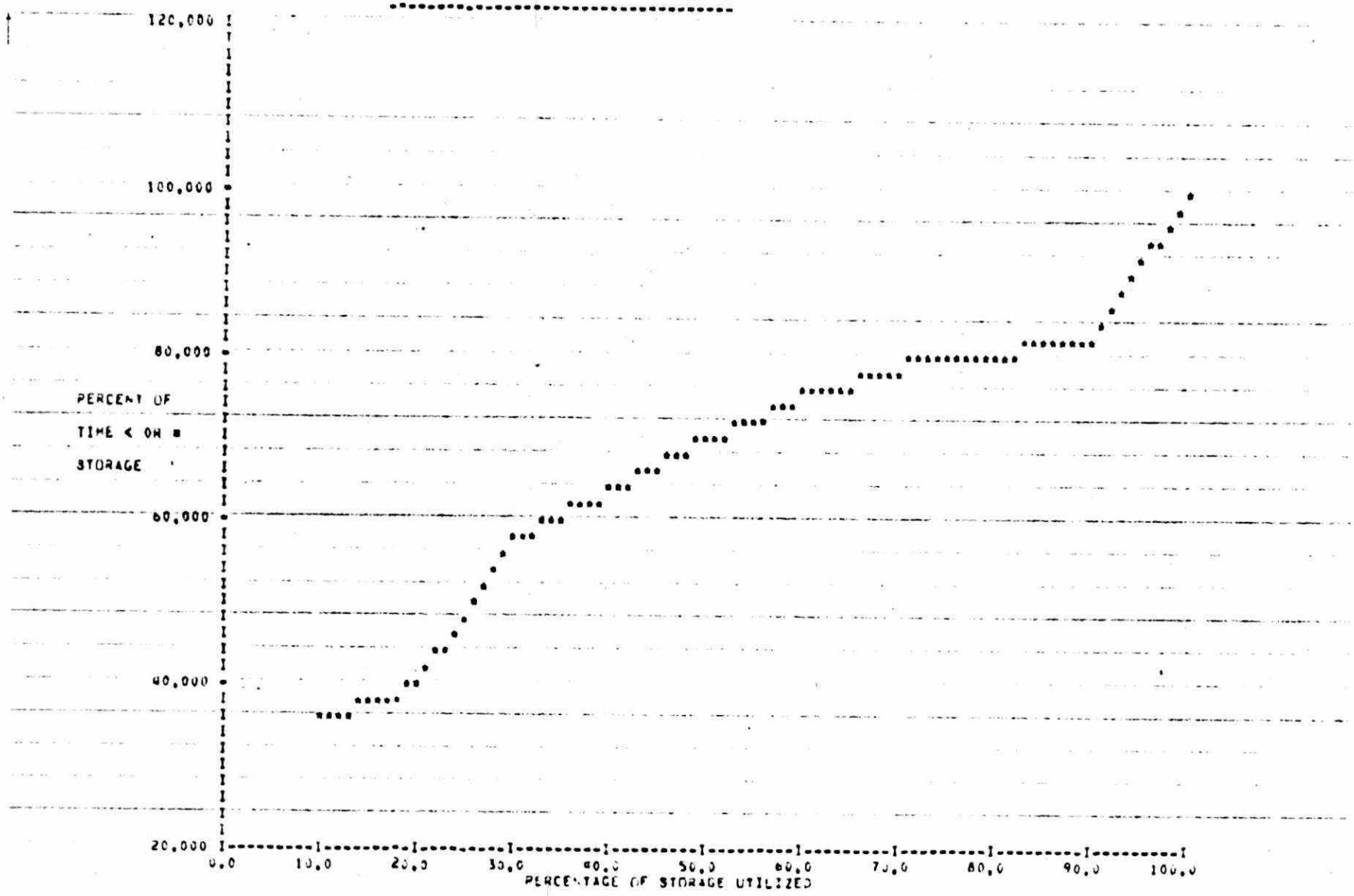
QUANTITY ANALYSIS

EXHIBIT ONE

TREATMENT RATE = .0500 IN/HR, 15n.1 CFS, 102,167 MGD
STORAGE CAPACITY= .1000 INCHES, 2n.1 ACRFT, 8,517 MG

YOLO INTERNATIONAL AIRPORT
CORE AREA

NORMALIZED STORAGE UTILIZATION CURVE



DEFINITIONS OF QUANTITY COLUMN HEADINGS

1 EVENT = SEQUENCING NUMBER.
2 DATE = DATE THIS EVENT BEGAN.
3 HR = NUMBER OF HOURS PAST MIDNIGHT THIS EVENT BEGAN.
4 HRS SC
STORAG = NUMBER OF HOURS SINCE END OF LAST EVENT, EXCLUDING SUMMER (MORE THAN, 2680 HOURS).

5 DURTN = DURATION OF STORM FROM FIRST HOUR OF RAIN TO LAST HOUR OF RAIN.
6 HRS = NUMBER OF HOURS IN WHICH RAINFALL OCCURRED DURING EVENT.
7 QUANTY = AMOUNT OF RAINFALL DURING THE EVENT IN INCHES.
7A RUNOFF
INCHES = RUNOFF DURING EVENT IN INCHES.
8 HRS TO
EMPTY = NUMBER OF HOURS FROM LAST RAI FALL TO END OF EVENT.
9 DURTN = TOTAL NUMBER OF HOURS STORAGE WAS UTILIZED. IE, LENGTH OF THE EVENT.
10 MAX = MAXIMUM AMOUNT OF STORAGE UTILIZED, IN INCHES.

11 NO = OVERFLOW EVENT SEQUENCING NUMBER.
12 ST = NUMBER OF HOURS ELAPSED BEFORE OVERFLOW STARTED. OR, IF NO OVERFLOW, HOUR OF MAXIMUM STORAGE.
13 DUR = NUMBER OF HOURS IN WHICH OVERFLOW OCCURED.
14 WASTE = QUANTITY OF WATER RELEASED UNTREATED, IN INCHES.
15 INITL = QUANTITY OF WATER RELEASED UNTREATED DURING THE FIRST 3 HOURS OF OVERFLOW.

16 HRS = NUMBER OF HOURS WATER WAS TREATED DURING THE PRESENT EVENT AND SINCE THE PREVIOUS EVENT.
17 QANTY = QUANTITY OF WATER TREATED DURING THE EVENT AND SINCE THE PREVIOUS EVENT.
18 AGE1 = AVERAGE AGE (HOURS) OF TREATED RUNOFF.
19 AGE2 = MAXIMUM AGE (HOURS) OF STORAGE ON FIRST IN, FIRST OUT BASIS.
20 AGE3 = MAXIMUM AGE (HOURS) OF STORAGE ON FIRST IN, LAST OUT BASIS.
21 AGE4 = QUANTITY WEIGHTED AVERAGE AGE (HRS) OF STORAGE ON FIRST IN, FIRST OUT BASIS.
22 AGE5 = QUANTITY WEIGHTED AVERAGE AGE (HRS) OF STORAGE ON FIRST IN, LAST OUT BASIS.

DAVISVILLE, CALIFORNIA — EXHIBIT ONE

QUALITY ANALYSIS — YOLO INTERNATIONAL AIRPORT CORE AREA

TREATMENT RATE = .0000 IN/HR, 0.0 CFS, 0.000 MGD
STORAGE CAPACITY= .0000 INCHES, .0 AC-FT, .000 MG

EVENT	DATE EVENT BEGAN YR	MO	DY	HR	RAIN FALL INCHS	STORM RUNOFF QUANTITY INCHS	TOTAL POUNDS SUSP	SETL	BOD	N	PO4	STORAGE SEG NO	INCHS CAPCTY	TOTAL POUNDS SUSP	SETL	BOD	N	PO4	OVERFLOW INCHS	TOTAL POUNDS SUSP	SETL	BOD	N	PO4
****1	********2	** 3	***** 4	***** 5	****** 6	***** 7	***** 8	***** 9	***** 10	***** 11	***** 12	***** 13	***** 14	***** 15	***** 16	***** 17	***** 18	***** 19	***** 20	***** 21	***** 22	***** 23
1	72 11	15	14	1.40	.56	3772	155	622	212	21	1	.53	3771	155	622	212	21	.15	1375	61	353	87	9
2	72 11	17	15	.16	.02	75	4	21	5	1	2	.02	75	4	21	5	1	.02	75	4	21	5	1
3	72 11	19	9	.15	.06	409	17	90	25	3	3	.05	409	17	90	25	3	.05	409	17	90	25	3
4	72 12	0	2	.43	.14	2735	98	786	184	19	4	.13	2735	98	786	184	19	.09	2066	66	628	142	15
5	72 12	6	11	.05	.00	32	2	9	2	0	5	0.00	32	2	9	2	0	0.00	32	2	9	2	0
6	72 12	6	14	.05	.00	35	2	10	2	0	6	0.00	35	2	10	2	0	0.00	35	2	10	2	0
7	72 12	6	20	.07	.01	77	4	19	5	1	7	0.00	77	4	19	5	1	0.00	77	4	19	5	1
8	72 12	6	24	.07	.02	179	9	41	11	1	8	.01	179	9	41	11	1	.01	179	9	41	11	1
9	72 12	7	5	.03	.01	139	7	29	8	1	9	.01	139	7	29	8	1	.01	139	7	29	8	1
10	72 12	7	11	.04	.01	114	6	25	7	1	10	.01	114	6	25	7	1	.01	114	6	25	7	1
11	72 12	16	19	.05	.02	346	16	119	25	3	11	.01	346	16	119	25	3	.01	346	16	119	25	3
12	72 12	16	23	.12	.05	1014	39	246	64	7	12	.04	1014	39	246	64	7	.04	1014	39	246	64	7
13	72 12	17	4	.12	.04	720	31	149	43	4	13	.03	720	31	149	43	4	.03	720	31	149	43	4
14	72 12	18	21	.66	.22	6513	253	846	345	35	14	.22	6513	253	846	345	35	.14	4727	175	639	253	25
15	73 1	8	8	.22	.09	2703	113	729	178	18	15	.08	2703	113	729	178	18	.04	1386	60	439	97	10
16	73 1	8	15	.56	.22	10171	439	1300	538	54	16	.22	10171	439	1300	538	54	.21	10060	431	1292	532	54
17	73 1	8	22	1.10	.42	8379	548	865	420	43	17	.42	8378	548	865	420	43	.04	1111	61	120	57	6
18	73 1	11	10	.76	.31	4592	399	523	239	24	18	.30	4592	399	523	239	24	.03	667	40	67	26	3
19	73 1	12	5	.47	.17	1659	192	186	88	9	19	.16	1659	192	186	88	9	.12	1412	155	156	73	7
20	73 1	16	4	1.37	.50	6012	794	759	321	32	20	.50	6012	794	759	321	32	.23	3791	426	518	206	21
21	73 1	16	19	.02	.00	0	3	1	0	0	21	0.00	0	3	1	0	0	0.00	0	3	1	0	0
22	73 1	16	21	.25	.07	237	51	32	13	1	22	.07	237	51	32	13	1	.04	116	27	17	7	1
23	73 1	17	21	.60	.24	1168	221	155	64	6	23	.23	1168	221	155	64	6	.17	1003	190	134	55	5
24	73 1	18	7	1.10	.42	1646	500	185	88	9	24	.41	1646	500	185	88	9	.21	1267	340	137	65	6
25	73 1	21	2	.19	.05	132	27	52	10	1	25	.05	132	27	52	10	1	.03	90	19	34	7	1
26	73 1	24	24	.05	.02	115	12	47	9	1	26	.01	115	12	47	9	1	.01	115	12	47	9	1
27	73 1	25	9	.07	.01	63	8	28	5	1	27	.01	63	8	28	5	1	.01	63	8	28	5	1
28	73 1	29	5	.12	.04	313	26	120	24	2	28	.03	313	26	120	24	2	.03	313	26	120	24	2
29	73 1	29	18	.27	.09	807	66	200	52	5	29	.09	807	66	200	52	5	.05	620	47	157	40	4
30	73 1	30	3	.05	.02	106	11	25	7	1	30	.01	106	11	25	7	1	.01	106	11	25	7	1
31	73 2	3	12	.02	.01	69	6	25	5	1	31	0.00	69	6	25	5	1	0.00	69	6	25	5	1
32	73 2	3	16	.13	.03	335	27	98	23	2	32	.03	335	27	98	23	2	.02	305	24	89	21	2
33	73 2	5	22	.03	.01	76	6	26	5	1	33	0.00	76	6	26	5	1	0.00	76	6	26	5	1
34	73 2	6	7	1.15	.44	7430	577	968	397	40	34	.43	7429	577	967	397	40	.12	2816	179	441	157	16
35	73 2	9	17	.10	.04	351	32	72	21	2	35	.03	351	32	72	21	2	.03	351	32	72	21	2
36	73 2	9	21	.45	.17	2361	241	302	126	13	36	.16	2361	241	302	126	13	.16	2361	241	302	126	13
37	73 2	10	20	.07	.03	167	19	26	9	1	37	.02	167	19	26	9	1	.02	167	19	26	9	1
38	73 2	11	21	.15	.05	326	35	50	19	2	38	.04	326	35	50	19	2	.04	326	35	50	19	2
39	73 2	12	17	.41	.15	891	106	137	50	5	39	.15	891	106	137	50	5	.05	346	30	60	20	2
40	73 2	14	5	.34	.11	945	98	130	51	5	40	.11	945	98	130	51	5	.03	241	28	41	14	1
41	73 2	27	9	.83	.32	8102	597	1300	454	46	41	.32	8102	597	1300	454	46	.08	1596	93	458	106	11
42	73 2	27	20	.14	.04	422	40	52	22	2	42	.04	422	40	52	22	2	.04	422	40	52	22	2
43	73 3	3	9	.47	.17	2310	192	352	128	13	43	.16	2310	192	352	128	13	.07	953	77	176	50	6
44	73 3	6	7	.43	.15	2350	201	334	128	13	44	.14	2350	201	334	128	13	.11	2067	176	298	114	11
AVE OF	44 EVNTS			.35	.13	1829	141	276	101	10														
AVE OF	44 OVHDS			.35	.13	1829	141	276	101	10		.13	1829	141	276	101	10	.06	1029	74	177	59	6

	SUSP	SETL	BOD	N	PHO
TOTAL POUNDS RUNOFF FROM WATERSHED	80463	6223	12127	4046	448
TOTAL POUNDS OVERFLOW TO RECEIVING WATER	80458	6222	12128	4043	448
CONCENTRATION OF POLLUTANTS IN OVERFLOW TO RECEIVING WATER (MG/L)	20.51	1.59	3.09	1.13	.11
FRACTION OF TOTAL RUNOFF OVERFLOWING TO RECEIVING WATER	1.00	1.00	1.00	1.00	1.01
FRACTION OF TOTAL RUNOFF INITIALLY OVERFLOWING TO RECEIVING WATER	.56	.52	.64	.58	.59

DAVISVILLE, CALIFORNIA — EXHIBIT ONE

QUALITY ANALYSIS

TREATMENT RATE = .1500 IN/HR, 156.1 CFS, 102,187 MGD
STORAGE CAPACITY= .1000 INCHES, 26.1 AC-FT, 8,517 MG

YOLO INTERNATIONAL AIRPORT
CORE AREA

EVENT	DATE EVENT YR	MO	DY	HR	RAIN FALL INCHS	STORM RUNOFF INCHS QANTY	SUSP	TOTAL POUNDS SETL	BOD	N	PO4	SEQ NO	STORAGE OVERFLOW INCHS QANTY	SUSP	TOTAL POUNDS SETL	BOD	N	PO4	FIRST 3 HOURS OVERFLOW INCH Q	SUSP	TOTAL POUNDS SETL	BOD	N	PO4
1	72	11	15	15	1.32	.52	3719	153	528	207	21	1	.09	670	34	76	35	3	.09	670	34	76	35	3
2	72	11	19	9	.15	.06	409	17	90	25	3		NO OVERFLOW											
3	72	12	6	6	.19	.08	1688	55	400	106	11		NO OVERFLOW											
4	72	12	18	22	.48	.19	5960	228	747	313	31		NO OVERFLOW											
5	73	1	8	15	.58	.22	10171	439	1306	538	54		NO OVERFLOW											
6	73	1	9	8	.51	.20	4630	340	477	236	24		NO OVERFLOW											
7	73	1	11	14	.52	.21	3259	290	352	168	17		NO OVERFLOW											
8	73	1	12	6	.23	.09	1106	123	120	57	6		NO OVERFLOW											
9	73	1	16	5	1.17	.47	5537	751	602	293	29	2	.07	879	141	96	46	5	.07	879	181	96	46	5
10	73	1	17	22	.50	.20	990	169	123	53	5		NO OVERFLOW											
11	73	1	18	8	1.04	.41	1637	498	188	88	9	3	.05	150	49	17	8	1	.02	82	25	9	4	0
12	73	2	0	9	.98	.39	6923	540	855	365	37	4	.03	614	55	68	32	3	.03	614	55	68	32	3
13	73	2	9	22	.30	.14	2167	223	266	115	12		NO OVERFLOW											
14	73	2	14	9	.20	.07	704	70	89	38	4		NO OVERFLOW											
15	73	2	27	13	.51	.20	5929	469	730	314	31	5	0.00	87	7	10	5	0	0.00	87	7	10	5	0
16	73	3	3	12	.20	.09	1310	108	168	73	7		NO OVERFLOW											
17	73	3	6	7	.30	.12	2087	176	298	114	11		NO OVERFLOW											
AVE OF	17 EVNTS				.59	.22	3420	272	439	182	18		.05	480	57	53	25	2	.05	466	52	52	24	2
AVE OF	5 OVRFLS				1.00	.40	4753	462	804	253	25													

AVERAGE ANNUAL STATISTICS FOR 1 YEARS OF RECORD FOR THE PERIOD BEGINNING 721115 AND ENDING 730306

	SUSP	SETL	BOD	N	PO4
TOTAL POUNDS WASHOFF FROM WATERSHED	80963	6223	12127	6846	836
TOTAL POUNDS OVERFLOW TO RECEIVING WATER	2399	286	265	126	12
CONCENTRATION OF POLLUTANTS IN OVERFLOW TO RECEIVING WATER (MG/L)	12.63	1.51	1.40	.65	.06
FRACTION OF TOTAL WASHOFF OVERFLOWING TO RECEIVING WATER	.03	.05	.02	.03	.03
FRACTION OF TOTAL WASHOFF INITIALLY OVERFLOWING TO RECEIVING WATER	.03	.04	.02	.03	.03

DAVISVILLE, CALIFORNIA — EXHIBIT ONE

POLLUTOGRAPH FOR EVENT

YOLO INTERNATIONAL AIRPORT
CORE AREA

TREATMENT RATE = .0000 IN/HR, 0.0 CFS, 0.000 MGD
STORAGE CAPACITY= .0000 INCHES, .0 AC-FT, .000 MG

EVENT	YR	MO	DY	HR	T(O)	RAINFALL	RUNOFF	CFS-OFF	RUNOFF POLLUTANT LOAD, IN LBS/HR					AVE CONCENTRATION, IN MG/L				
									SUSP	SETL	BOD	N	PO4	SUSP	SETL	BOD	N	PO4
1	72	11	15	14	1	.08	.01	37.7	52.5	1.9	33.6	5.2	.6	6.2	.2	4.0	.61	.07
1	72	11	15	15	2	.22	.09	276.5	934.6	27.0	222.0	58.6	6.0	15.0	.4	3.6	.94	.10
1	72	11	15	16	3	.14	.06	176.0	388.4	11.9	77.0	23.0	2.3	9.8	.3	1.9	.56	.06
1	72	11	15	17	4	.15	.06	148.5	393.4	13.0	61.9	21.8	2.2	9.3	.3	1.5	.52	.05
1	72	11	15	18	5	.34	.14	427.4	1197.6	55.1	180.4	62.2	6.2	12.5	.6	1.5	.65	.07
1	72	11	15	19	6	.28	.11	351.9	606.7	33.9	65.7	31.1	3.1	7.7	.4	.8	.39	.04
1	72	11	15	20	7	.03	.01	37.7	17.7	1.8	2.0	.9	.1	2.1	.2	.2	.11	.01
1	72	11	15	21	8	.01	.00	12.6	4.7	.5	.6	.2	.0	1.7	.2	.2	.09	.01
1	72	11	15	22	9	.15	.06	148.5	176.0	10.4	18.6	9.0	.9	4.2	.2	.4	.21	.02
7	72	12	6	20	1	.07	.01	22.5	76.8	4.0	19.4	8.9	.5	15.2	.8	3.8	.97	.10

VISVILLE, CALIFORNIA — EXHIBIT ONE

POLLUTOGRAPH FOR EVENT

YOLO INTERNATIONAL AIRPORT
CORE AREA

TREATMENT RATE = .0500 IN/HR, 158.1 CFS, 102.187 MGD
STORAGE CAPACITY= .1000 INCHES, 26.1 AC-FT, 8.517 MG

EVENT	YR	MO	DY	HR	T(O)	RAINFALL	RUNOFF	CFS-OFF	RUNOFF POLLUTANT LOAD, IN LBS/HR					AVE CONCENTRATION, IN MG/L				
									SUSP	SETL	BOD	N	PO4	SUSP	SETL	BOD	N	PO4
1	72	11	15	15	1	.22	.09	276.5	934.6	27.0	222.0	58.6	6.0	15.0	.4	3.6	.94	.10
1	72	11	15	16	2	.14	.06	176.0	388.4	11.9	77.0	23.0	2.3	9.8	.3	1.9	.56	.06
1	72	11	15	17	3	.15	.06	148.5	393.4	13.0	61.9	21.8	2.2	9.3	.3	1.5	.52	.05
1	72	11	15	18	4	.34	.14	427.4	1197.6	55.1	180.4	62.2	6.2	12.5	.6	1.5	.65	.07
1	72	11	15	19	5	.28	.11	351.9	606.7	33.9	65.7	31.1	3.1	7.7	.4	.8	.39	.04
1	72	11	15	20	6	.03	.01	37.7	17.7	1.8	2.0	.9	.1	2.1	.2	.2	.11	.01
1	72	11	15	21	7	.01	.00	12.6	4.7	.5	.6	.2	.0	1.7	.2	.2	.09	.01
1	72	11	15	22	8	.15	.06	148.5	176.0	10.4	18.6	9.0	.9	4.2	.2	.4	.21	.02
2	72	11	19	9	1	.15	.06	148.5	408.7	16.9	89.9	25.0	2.6	9.0	.4	2.1	.59	.06
3	72	12	6	4	1	.13	.05	163.4	1300.2	80.9	307.6	81.7	8.4	35.6	1.1	8.4	2.22	.23
3	72	12	6	5	2	.06	.02	75.4	381.4	14.4	92.8	24.1	2.5	22.5	.8	5.5	1.42	.15

Exhibit 2: Test Problem #2

Test problem #2 incorporates the following analyses using the STORM program.

Quantity and quality of runoff from a watershed comprised of both urban and nonurban land uses.

Snowfall and snowmelt analysis.

Storage/Treatment analysis.

Pollutographs for selected events.

Land surface erosion for both urban and nonurban portions of a watershed.

The following pages of this exhibit show the input data and the corresponding output for the above analyses.

```
A1         TEST 2                    STORM                                                    L2520
A2  SNOWMELT/RAINFALL RUNOFF FOR URBAN AND NONURBAN AREAS - LAND SURFACE EROSION
A3   BOISE, IDAHO URBAN STUDY                                                    EXHIBIT TWO
B1     1         1         1         1         1         1
B2     60        3         1        -4         0
C1  WEATHER BUREAU, BOISE AIRPORT          5         0    720102         0         1
C 720102  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0
C 720104  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0
C 720110  0  0  0  0  0  0  0  0  0  0  0  0  0  2  0  0  0  0  0  0  0  0  0  0  0
C 720111  0  0  0  2  2  1  3  8  2  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720112  0  0  1  1  1  1  2  1  1  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720118  0  3  3  2  6  5  5  3  1  4  0  3  4  4  6  0  0  0  0  0  0  0  0  0  0
C 720120  0  0  3  5  2  0  0  1  1  7  4  0  0  0  0  2  5  9  4  4  4  1  0
C 720121  0  0  0  1  0  1  2  5  0  0  0  0  0  0  0  0  0  0  0  0  2  7  4  6
C 720122  4  6  5  5  5  1  2  0  0  0  2  2  0  0  0  0  0  0  0  0  0  0  2  2
C 720123  2  2  6  2  1  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720127  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2  1  2  1
C 720206  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0
C 720209  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0
C 720213  0  0  0  0  0  0  0  1  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0
C 720214  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  5  4  1  0  0  0  0  0  0
C 720215  0  0  0  0  0  0  0  0  0  0  0  2  2  2  0  0  0  0  0  0  0  0  0  0
C 720217  0  0  0  0  0  0  0  1  0  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720222  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0
C 720223  0  0  0  0  0  0  0  0  0  0  0  0  0  5  1  0  0  0  0  1  0  0  2  0  0
C 720226  0  0  0  0  0  0  1  1  2  0  0  2  0  0  0  0  0  0  0  0  0  0  0  0
C 720227  0  0  0  0  0  0  0  4  1  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0
C 720228  0  0  3  2  7  8  3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  12  0
C 720229  0  0  0  0  0  0  0  2  0  0  0  0  0  0  0  0  0  0  0  0  2  5  6  4
C 720301  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720302  4  4  3  5  2  0  0  0  0  0  0  3  5  7  4  9  6  0  0  0  0  0  0  0
C 720311  5  3  0  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720312  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2  1  0  0  0  0  0  0
C 720313  0  0  0  0  0  0  0  0  0  0  0  0  2  0  0  0  0  0  0  0  0  0  0  0
C 720318  0  0  0  0  0  0  0  0  0  0  0  10  11  10  11  3  4  6  0  0  0  0  0  0
C 720323  0  0  0  0  3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720325  0  2  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720402  0  0  4  2  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720403  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720405  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0
C 720407  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720411  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  13  0  0  0
C 720412  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  10  2  1  0  1  0  0  0
C 720416  0  0  0  0  0  0  0  1  3  0  7  4  0  0  0  0  0  0  0  0  0  0  0  0
C 720421  0  0  0  3  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720429  0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720506  0  0  0  0  0  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720508  0  3  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720520  0  0  0  0  0  0  0  0  0  0  0  0  0  0  4  3  0  0  0  0  0  0  0  0
C 720521  0  3  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  2  1  1  3  3  0  0  0
C 720524  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720606  0  0  0  0  0  0  0  0  0  0  0  0  0  0  26  2  0  0  0  0  0  0  0  0  0
C 720607  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  13  2  9  4  0  0  0
C 720608  0  0  0  0  0  0  0  0  0  0  0  2  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720609  1  8  1  0  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  14
C 720610  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2  0  0  0  0  0  0  0
```

```
C 720925  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720721  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720815  1  3  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720905  0  0  0  0  4  6  2  2  1  0  0  0  0  5  19  5  0  0  0  0  0  0  0  0  0  0  0  0
C 720911  0  0  0  0  4  4  2  13  2  0  1  0  1  0  0  2  0  0  0  0  0  0  0  0  0  0  0  0
C 720915  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720919  0  0  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720921  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 720925  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  2  1  1  1  0  0  0  0  0  1
C 720927  2  4  5  1  1  8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721009  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  12  14  1  0  0  0  2
C 721010  2  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721011  0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721015  0  0  1  2  1  3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721019  0  0  0  0  0  0  1  5  2  0  0  0  0  0  10  3  0  3  3  0  0  0  1  0  0  0  0  3
C 721103  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0
C 721104  1  1  2  1  3  2  5  7  0  0  0  0  0  0  0  0  0  0  0  0  0  7  7  0  0  0  0  0
C 721105  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721108  0  0  0  12  4  0  5  1  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721110  0  0  0  0  1  2  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721111  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721115  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721116  0  0  0  0  0  0  0  0  0  0  0  0  1  2  2  0  1  1  0  0  0  0  1  1  0  0  0  1
C 721117  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721118  0  1  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721125  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  2  1  1  3  0  0  0  0  0  0  0  0
C 721126  0  0  0  0  0  1  3  2  0  1  3  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721203  0  0  0  0  0  0  0  0  0  2  3  1  3  1  2  2  3  3  0  0  0  0  0  0  0  0  0  0
C 721206  0  0  0  0  0  2  2  4  2  2  5  1  2  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721207  0  0  0  0  0  0  0  1  1  1  2  0  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721209  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721212  0  0  0  1  2  2  1  0  1  0  1  0  1  2  1  1  1  0  0  0  0  0  0  0  0  0  0  0
C 721213  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721217  0  0  0  0  0  2  1  9  8  6  4  3  2  0  0  0  1  3  0  0  0  0  0  0  0  0  0  0
C 721218  0  0  1  0  0  0  0  1  0  0  0  0  0  0  0  0  0  3  4  2  0  0  0  0  0  0  0  0
C 721219  0  0  0  2  2  2  3  0  0  1  0  0  1  1  2  0  0  1  2  0  0  0  0  0  0  0  0  0
C 721220  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0
C 721222  0  0  0  0  0  0  4  0  0  0  0  0  0  2  4  4  0  0  0  0  0  0  0  0  0  0  0  0
C 721223  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  4  7  0  0  0  0
C 721224  1  2  2  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C 721226  0  2  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C2
D1     5        0       34      .50       1      .07
241317201O1 35 22
241317201O2 40 22
241317201O3 30 15
241317201O4 27 12
241317201O5 32 21
241317201O6 3n 22
241317201O7 40 30
241317201O8 40 23
241317201O9 47 32
241317201I0 39 33
241317201I1 49 32
241317201I2 43 30
241317201I3 31 14
241317201I4 34 14
241317201I5 32 16
241317201I6 33 16
241317201I7 44 24
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241317201116 43 38
241317201119 49 40
241317201[illegible] 48 41
241317201121 44 37
241317201122 47 36
241317201123 44 34
241317201124 38 29
241317201125 41 32
241317201126 34 25
241317201127 32 19
241317201128 29  7
241317201129 27 11
241317201130 31  8
241317201131 27 10
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241317201[illegible] 25  6
241317201[illegible] 29  7
241317201204 29 14
241317201205 31 18
241317201206 41 27
241317201207 44 31
241317201208 40 29
241317201209 44 28
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241317201212 50 29
241317201213 45 31
241317201214 36 28
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241317201216 50 36
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241317201218 57 37
241317201219 61 36
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241317201314 57 33
241317201315 62 36
241317201316 67 39
241317201317 72 44
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241317200413 48 29
241317200414 55 30
241317200415 63 32
241317200416 51 33
241317200417 44 23
241317200418 49 27
241317200419 50 23
241317200420 61 33
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241317200422 52 32
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241317200514 78 57
241317200515 63 57
241317200516 67 47
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24131720707 95 56
24131720708 94 61
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24131720711 87 54
24131720712 97 61
24131720713 94 62
24131720714 90 61
24131720715 89 52
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241317200718 95 57
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241317200720 72 43
241317200721 73 53
241317200722 81 50
241317200723 95 59
241317200724 95 57
241317200725 96 58
241317200726 94 55
241317200727 92 62
241317200728 94 60
241317200729 99 64
241317200730 92 67
241317200731 97 66
241317200801 92 65
241317200802 96 58
241317200803 87 55
241317200804 93 56
241317200805 98 61
241317200806 98 59
241317200807 95 61
241317200808101 62
241317200809101 60
241317200810 99 64
241317200811 92 65
241317200812 95  6
241317200813 80 62
241317200814 93 64
241317200815 94 65
241317200816 96 52
241317200817 75 54
241317200818 93 69
241317200819 88 62
241317200820 89 55
241317200821 89 58
241317200822 84 58
241317200823 77 53
241317200824 81 51
241317200825 84 52
241317200826 90 58
241317200827 94 61
241317200828 97 60
241317200829 92 69
241317200830 88 62
241317200831 83 50
241317200901 84 50
241317200902 85 54
241317200903 86 55
241317200904 80 55
241317200905 76 55
241317200906 84 49
241317200907 75 46
241317200908 87 54
241317200909 72 52
241317200910 87 50
241317200911 55 49
241317200912 01 45
241317200913 08 43
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24131720914 74 44
24131720915 79 47
24131720916 83 53
24131720917 82 48
24131720918 80 57
24131720919 73 45
24131720920 80 37
24131720921 82 54
24131720922 87 45
24131720923 58 38
24131720924 55 37
24131720925 56 28
24131720926 59 42
24131720927 54 38
24131720928 81 49
24131720929 65 34
24131720930 72 38
24131721001 78 44
24131721002 76 43
24131721003 77 48
24131721004 81 51
24131721005 80 46
24131721006 65 37
24131721007 70 40
24131721008 74 48
24131721009 69 45
24131721010 66 49
24131721011 70 48
24131721012 69 44
24131721013 65 47
24131721014 69 46
24131721015 62 47
24131721016 63 41
24131721017 65 41
24131721018 67 43
24131721019 53 45
24131721020 67 45
24131721021 62 46
24131721022 68 40
24131721023 59 43
24131721024 60 32
24131721025 63 36
24131721026 54 30
24131721027 52 24
24131721028 47 34
24131721029 47 28
24131721030 47 17
24131721031 47 23
24131721101 48 37
24131721102 53 40
24131721103 61 42
24131721104 55 46
24131721105 49 32
24131721106 54 34
24131721107 54 39
24131721108 47 34
24131721109 52 34
24131721110 52 41
24131721111 48 34
24131721112 47 33
```

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241317211113 54 37
241317211-4 50 42
241317211115 51 42
241317211116 47 37
241317211117 47 37
241317211118 47 34
241317211119 40 33
241317211120 44 28
241317211121 45 29
241317211122 40 27
241317211123 38 27
241317211124 41 22
241317211125 45 29
241317211126 51 34
241317211127 40 24
241317211128 37 24
241317211129 40 27
241317211130 44 23
241317212001 52 23
241317212002 54 38
241317212003 36 19
241317212004 24 05
241317212005 15 -8
241317212006 22 07
241317212007 18 06
241317212008 07-19
241317212009 05-21
241317212010 -1-23
241317212011 04-22
241317212012 08 -4
241317212013 15-14
241317212014 10 -9
241317212015 19 -7
241317212016 29 17
241317212017 40 25
241317212018 44 34
241317212019 47 37
241317212020 52 35
241317212021 51 46
241317212022 52 38
241317212023 53 39
241317212024 45 36
241317212025 44 35
241317212026 46 39
241317212027 44 34
241317212028 40 31
241317212029 39 25
241317212030 37 25
241317212031 40 23
E1 NOISE HEIGHTS      2      4.6      .7
E2   420      .15      .90      1.2      0      0      0      0
E3   .05      .01      .01      .02      .14      .20      .24      .34      .30      .20
E3   .09      .03      .02
FIXED          10      30      300      30
F2
FIXED          90      10      20      100
F2
M1   100      .25      1.9      1      25      9999      1.      3.5
M2   .2      .01      .01      .02      .14      .20      .24      .34      .30      .20
M2   .09      .03      .02
```

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J1    20        5      3.1       .5       .35
K1     0        1
K2   111   723015       0        2         4        5        8        9       10       12
K2   112   723015      14       18        20       25       33       35       33       28
K2   113   723015      22       10        10        5        2        1,       0        0
K2
*          SOIL SERIES IDENTIFICATION REFERENCE *SOIL SURVEY AND INTERPRETATIONS
*          FOR THE BOISE FRONT, ADA COUNTY, IDAHO, USDA SCS, FEB 1972,TABLE 2
P SOIL SERIES IDENTIFICATION BY SLOPE AND SOIL TYPE
P1 DATA PAR              1        2        3        1
P2 SLOPE GROUP           1        0        4       12       25       40       69       80
P2 SLOPE GROUP           2        0        2        4        7
P4 SOIL TYPE  AC         1       40      .53
P4 SOIL TYPE  AD         1       10      .32       20      .39       50      .50
P4 SOIL TYPE  AE         1       23      .39       40      .48
P4 SOIL TYPE  BT         1       18      .34       34      .38       40      .34
P4 SOIL TYPE  CA         1       50      .37       70      .51
P4 SOIL TYPE  CI         1       10      .43       17      .58
P4 SOIL TYPE  CV         1       10      .43       17      .58
P4 SOIL TYPE  DP         1       38      .35       42      .55       60      .58
P4 SOIL TYPE  EN         1       26      .28       35      .36       60      .58
P4 SOIL TYPE  GR         1       05      .35       27      .43       33      .38
P4 SOIL TYPE  HA         1       46      .38       60      .52
P4 SOIL TYPE  HB         1       12      .28       30      .34       50      .54
P4 SOIL TYPE  HH         1       12      .33       30      .34       50      .54
P4 SOIL TYPE  LA         1       35      .54       60      .56
P4 SOIL TYPE  LH         1       14      .52       53      .50       60      .57
P4 SOIL TYPE  MD         1       60      .58
P4 SOIL TYPE  MS         1       12      .34       18      .56       40      .56
P4 SOIL TYPE  PT         1       30      .42       60      .56
P4 SOIL TYPE  RY         1       19      .43       24      .56
P4 SOIL TYPE  VD         1       24      .24       29      .57       42      .26
P4 SOIL TYPE  BI         2       08      .38       25      .42       60      .38
P4 SOIL TYPE  EH         2       09      .45       15      .50       22      .60
P4 SOIL TYPE  FA         2       35      .28       40      .58
P4 SOIL TYPE  JN         2       25      .30       60      .48
P4 SOIL TYPE  MB         2       20      .37       40      .56
P4 SOIL TYPE  MT         2       20      .38       40      .56
P4 SOIL TYPE  RA         2       20      .23       35      .59
P4 SOIL TYPE  PA         2       50      .56
P4 SOIL TYPE  TR         2       18      .58
Q  SED TRAP                    .90
R  OPEN                  RE      5      150         3        2                 .32       1.
R  OPEN                  LAE    75                                                     .43
R  OPEN                  STH    10                                                     .64
R  SINGLE                LBB    40      100        -2                               .70
R  SINGLE                LMH    60      100         2                               .5
R  NONURB                SER    20      150                                         .1
R  NONURB                VDE    15      150                                         .1
R  NONURB                PAC     5      150                                         .1
END
T1     1
T2   .01        1        1        0        3        0        0
T3   .10
TM     29
TS     1        7       15       18       21       22
```

STORM, L2520, VERSION DATED MAY 1974, UPDATED 7x

TEST 2 PROGRAM OUTPUT

TEST 2 STORM L2520
SNOWMELT/RAINFALL RUNOFF FOR URBAN AND NONURBAN AREAS W LAND SURFACE EROSION
BOISE, IDAHO URBAN STUDY EXHIBIT TWO

NASD	ISAD	NONURB	ISED	IQUAL	IEVNT
1	1	1	1	1	1

NSUMR	LEXT	LINE	LDATE	LHR
60	3	1	0	0

TITLE OF RAIN GAGE
WEATHER BUREAU, BOISE AIRPORT

IN	IFILE	ISTART	IEND	IR
5	0	720102	999999	1

RAINFALL DATA FOR WEATHER BUREAU, BOISE AIRPORT
HOURLY RAINFALL, IN HUNDRETHS OF AN INCH

YEAR	MO	DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1972	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
1972	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
1972	1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1972	1	11	0	0	0	2	2	1	5	0	2	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	20
1972	1	12	0	0	1	1	1	1	2	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
1972	1	18	0	3	3	2	6	5	5	3	1	4	0	3	0	4	6	0	2	3	9	0	4	4	1	0	49
1972	1	20	0	0	5	5	2	0	1	1	1	7	0	0	0	0	0	0	0	0	0	0	2	7	4	0	50
1972	1	21	0	0	0	1	0	1	2	5	0	0	2	2	0	0	0	0	0	0	0	0	0	0	2	2	26
1972	1	22	4	6	5	3	5	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34
1972	1	23	2	2	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	2	1	14
1972	1	27	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	6
1972	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	2	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	2	13	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	5	4	1	0	0	0	0	0	0	2
1972	2	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
1972	2	15	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0
1972	2	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3
1972	2	22	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1
1972	2	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	9
1972	2	26	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
1972	2	27	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	5
1972	2	28	0	0	3	2	7	3	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3	12	0	36
1972	2	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
1972	3	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	5	6	6	19
1972	3	2	4	0	3	5	2	0	0	0	0	0	0	3	5	7	0	0	0	0	0	0	0	0	0	0	57
1972	3	11	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	5
1972	3	12	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	4
1972	3	13	0	0	0	0	0	0	0	0	0	0	10	11	10	11	3	0	0	0	0	0	0	0	0	0	2
1972	3	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55
1972	3	23	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
1972	3	25	0	2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
1972	4	2	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
1972	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	4	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	13
1972	4	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	2	0	1	0	0	0	14
1972	4	12	0	0	0	0	0	0	0	0	3	0	7	4	0	0	0	0	0	0	0	0	0	0	0	0	15
1972	4	16	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	8
1972	4	21	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1972	4	29	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1972	5	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4
1972	5	8	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	7
1972	5	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	3	3	0	0	18
1972	5	21	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	5	24	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28
1972	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	13	0	2	9	4	0	26
1972	6	7	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1972	6	8	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	14	26
1972	6	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	3
1972	6	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	6	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	21
1972	7	21	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	5
1972	8	15	1	3	1	0	0	0	0	0	0	0	0	0	0	0	5	19	0	0	0	0	0	0	0	0	46
1972	9	5	0	0	0	0	0	6	2	2	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	29
1972	9	11	0	0	0	0	0	0	2	13	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0

RAINFALL DATA FOR WEATHER BUREAU, BOISE AIRPORT
HOURLY RAINFALL, IN HUNDRETHS OF AN INCH

YEAR	MO	DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1972	9	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	9	19	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1972	9	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
1972	9	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	1	5
1972	9	27	2	4	5	1	1	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27
1972	10	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	10	1	0	0	2	25
1972	10	10	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
1972	10	11	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1972	10	15	0	0	1	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
1972	10	19	0	0	0	0	0	0	1	5	2	0	0	0	0	0	0	10	3	0	3	3	0	0	0	0	27
1972	11	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	4
1972	11	4	1	1	2	1	3	2	5	7	6	0	0	0	0	0	0	0	0	0	7	7	0	0	0	0	36
1972	11	5	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1972	11	8	0	0	0	12	4	0	5	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
1972	11	10	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
1972	11	11	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	11	15	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	11	16	0	0	0	0	0	0	0	0	0	0	0	1	2	2	0	1	0	0	0	0	0	1	1	1	10
1972	11	17	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1972	11	18	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	9
1972	11	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1	3	0	0	0	0	8
1972	11	26	0	0	0	0	0	1	3	2	0	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	11
1972	12	3	0	0	0	0	0	0	0	0	0	2	3	1	3	1	2	2	3	3	0	0	0	0	0	0	20
1972	12	6	0	0	0	0	0	2	2	4	2	2	5	1	2	1	1	0	0	0	0	0	0	0	0	0	22
1972	12	7	0	0	0	0	0	0	0	1	1	1	2	0	1	1	1	0	0	0	0	0	0	0	0	0	8
1972	12	8	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1972	12	12	0	0	0	1	2	2	1	0	1	0	1	0	1	2	1	1	0	0	0	0	0	0	0	0	14
1972	12	13	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	12	17	0	0	0	0	0	2	1	9	8	0	4	3	2	0	0	0	1	3	0	0	0	0	0	0	39
1972	12	18	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	0	11
1972	12	19	0	0	0	2	2	2	3	0	0	1	0	0	1	1	2	0	0	1	2	0	0	0	0	0	17
1972	12	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
1972	12	22	0	0	0	0	0	4	0	0	0	0	0	0	0	0	2	4	4	0	0	0	0	0	0	0	14
1972	12	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7	8	19
1972	12	24	1	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
1972	12	28	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4

END OF RAINFALL DATA.
91 RAINFALL DAYS PROCESSED ENCOMPASSING 365 DAYS (1 YEARS) OF RECORD.

SNOW COMPUTATIONS DATA

ITAPE	IFILE	IFREZ	PACK	ITMP	COEF
5	0	30	.50	1	.070

FIRST DAY OF PRECIPITATION RECORD = 720102 WHICH SHOULD EQUAL ISTART FIRST DAY OF TEMPERATURE DATA = 720102.

HOURLY RAINFALL PLUS SNOWMELT DATA FOR WEATHER BUREAU, BOISE AIRPORT
IN HUNDREDTHS OF AN INCH

YEAR	MO	DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1972	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	1	7	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1	-1	0	0	0	0	0	0	0	0	0	-7
1972	1	9	0	0	0	0	0	0	0	0	-4	-4	-4	-4	-4	-4	-4	-4	-3	0	0	0	0	0	0	0	-35
1972	1	10	-0	-0	-0	-0	-0	-0	-0	-2	-2	-2	-2	-2	-2	-2	-2	-0	-0	-0	-0	-0	-0	-0	-0	-0	-12
1972	1	11	0	0	0	2	2	1	5	6	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
1972	1	12	0	0	1	1	1	1	2	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
1972	1	18	0	5	3	2	6	5	5	3	1	4	0	3	4	4	6	0	0	0	0	0	0	0	0	0	49
1972	1	20	0	0	3	5	2	0	0	1	1	7	4	0	0	0	0	0	2	3	9	4	4	1	0	0	50
1972	1	21	0	0	0	1	0	1	2	5	0	0	0	0	0	0	0	0	0	0	0	0	2	7	4	6	28
1972	1	22	4	6	5	3	5	1	4	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	2	2	34
1972	1	23	2	2	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
1972	1	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	2	7	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1	-1	0	0	0	0	0	0	0	0	0	-7
1972	2	9	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	2	13	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2
1972	2	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	2	15	-0	-0	-0	-0	-0	-0	-0	-0	-2	-2	-2	-2	-2	-3	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-17
1972	2	17	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
1972	2	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
1972	2	23	0	0	0	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0	1	0	0	2	0	0	9
1972	2	26	0	0	0	0	0	0	0	1	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	6
1972	2	27	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	2	28	0	0	3	2	7	8	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	12	0	38
1972	2	29	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	3	2	-4	-4	-3	-5	-2	-0	-0	-0	-3	-3	-3	-6	-6	-10	-10	-0	-0	-0	-0	-0	-0	-0	-0	-0	-76
1972	3	11	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
1972	3	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	0	0	0	4
1972	3	13	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
1972	3	18	0	0	0	0	0	0	0	0	0	0	10	11	10	11	3	4	6	0	0	0	0	0	0	0	55
1972	3	23	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
1972	3	25	0	2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
1972	4	2	0	0	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
1972	4	4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
1972	4	7	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	4	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	13
1972	4	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	2	1	0	1	0	0	0	14
1972	4	16	0	0	0	0	0	0	0	1	3	0	7	4	0	0	0	0	0	0	0	0	0	0	0	0	15
1972	4	21	0	0	0	3	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
1972	4	29	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1972	5	6	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1972	5	8	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
1972	5	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	0	0	0	0	0	0	0	0	7
1972	5	21	0	3	0	1	4	0	0	0	0	0	0	0	0	0	0	0	2	1	1	3	3	0	0	0	18
1972	5	24	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	20	2	0	0	0	0	0	0	0	0	0	24
1972	6	7	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	13	2	9	4	0	0	28
1972	6	8	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1972	6	9	1	8	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	14	26	26
1972	6	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	3
1972	6	25	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	7	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	1	0	0	0	0	0	21

HOURLY RAINFALL PLUS SNOWMELT DATA FOR WEATHER BUREAU, BOISE AIRPORT
IN HUNDREDTHS OF AN INCH

YEAR	MO	DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1972	8	15	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
1972	9	5	0	0	0	0	0	0	2	2	1	0	0	0	0	5	19	5	0	0	0	0	0	0	0	0	46
1972	9	11	0	0	0	0	0	4	2	13	2	0	1	0	1	0	0	2	0	0	0	0	0	0	0	0	29
1972	9	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	9	19	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1972	9	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
1972	9	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	1	5
1972	9	27	2	4	5	1	1	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27
1972	10	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	10	1	0	0	2	25
1972	10	10	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
1972	10	11	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1972	10	15	0	0	1	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
1972	10	19	0	0	0	0	0	0	1	5	2	0	0	0	0	0	10	3	0	3	3	0	0	0	0	0	27
1972	11	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	4
1972	11	4	1	1	2	1	3	2	5	7	0	0	0	0	0	0	0	0	0	0	9	7	7	0	0	0	36
1972	11	5	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1972	11	8	0	0	0	12	4	0	5	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
1972	11	10	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
1972	11	11	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	11	15	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	11	16	0	0	0	0	0	0	0	0	0	0	0	1	2	2	0	1	1	0	0	0	0	1	1	1	10
1972	11	17	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1972	11	18	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
1972	11	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1	3	0	0	0	0	8
1972	11	26	0	0	0	0	0	1	3	2	0	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	11
1972	12	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	12	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	12	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	12	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	12	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	12	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	12	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	12	18	-0	-0	-1	-0	-0	-0	-0	-1	-6	-6	-6	-6	-6	-6	-6	-6	-1	-0	-3	-4	-2	-0	-0	-0	-60
1972	12	19	-0	-0	-0	-2	-2	-2	-3	-0	-7	-8	-7	-7	-8	-8	-9	-7	-0	-1	-2	-0	-0	-0	-0	-0	-73
1972	12	20	-0	-0	-0	-0	-0	-0	-0	-0	-1	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-1	-0	-0	-2
1972	12	22	0	0	0	0	0	4	0	0	0	0	0	0	0	2	6	6	0	0	0	0	0	0	0	0	14
1972	12	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7	8	19
1972	12	24	1	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
1972	12	26	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4

URBAN WATERSHED DATA

NAMEAS	MXLG	EXPTF	REFF
BOISE HEIGHTS	2	4.000	.700

AREA	CPER	CIMP	RFU	IGU	DVC	DVUMX	RU
420.00	.15	.90	1.20	0	0.00	0.00	0.00

DEPRESSION STORAGE (INCHES) DAILY EVAPORATION RATES FOR EACH MONTH, JAN-DEC IN INCHES/DAY

.050	.01	.01	.02	.14	.20	.24	.34	.30	.20	.09	.03	.02

INPUT DATA DESCRIBING LAND USE AND POLLUTANTS

LNDUSE	PRCNT	FIMP	STLEN	NCLEAN	DD	POUNDS POLLUTANT PER 100LB DD				
						SUSP	SETL	BOD	N	PO4
SINGLE	10.0	30.0	3.0.0	30	-0.00	-0.000	-0.000	-0.000	-0.000	-0.000
OPEN	90.0	10.0	20.0	100	-0.00	-0.000	-0.000	-0.000	-0.000	-0.000

COMPUTED RU-OFF COEFFICIENT FOR WATERSHED IS .24000

FRACTION OF URBAN WATERSHED THAT IS IMPERVIOUS IS .1200

LAND USE AND POLLUTANT DATA WITH DEFAULT VALUES ADDED

LAND USE	PRCNT OF LND AREA	PRCNT IMPERV	GUTTERS FT/AC	SWEEPING INTRVL, DYS	CD RATE LBS/DAY	********** LBS POLLUTANT/100LBS DD **********				
						SUSP	SETL	BOD	N	PO4
SINGLE	10.0	30.0	3.0.0	30	68.2	11.100	1.100	.500	.048	.005
OPEN	90.0	10.0	20.0	100	113.4	11.100	1.100	.500	.048	.005

NON URBAN WATERSHED DATA

	AREAN	CN	HFN	IQN	DVN	DVNMX	AN	EXPTN
	180.0	.25	1.90	1	25.0	9999.0	1.00	3.50

DEPRESSION STORAGE (INCHES)	DAILY EVAPORATION RATES FOR EACH MONTH, JAN-DEC IN INCHES/DAY											
.200	.01	.01	.02	.14	.20	.24	.34	.30	.20	.09	.03	.02

	SUSP	SETL	BOD	N	PO4
POLLUTANT ACCUMULATION RATES (LBS/ACRE/DAY)	20.00	5.00	3.10	.50	.35
(LBS/DAY)	3600.0	900.0	558.0	90.0	63.0

INPUT HYDROGRAPH TRANSFORMATION COEFFICIENTS, A= 0.00, B= 1.00 C=A+B

STATION	DATE	DISCHARGES IN CFS											
III	720915	0.00	2.00	4.00	5.00	8.00	9.00	10.00	12.00	14.00	16.00	20.00	25.00
		30.00	35.00	33.00	26.00	22.00	16.00	10.00	5.00	2.00	1.00	0.00	0.00

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*       SOIL SERIES IDENTIFICATION REFERENCE= *SOIL SURVEY AND INTERPRETATIONS
*       FOR THE BOISE FRONT*, ADA COUNTY, IDAHO, USDA SCS, FEB 1972,TABLE 2

P SOIL SERIES IDENTIFICATION BY SLOPE AND SOIL TYPE


SLOPE GROUP=   1 NO. OF SLOPES IN GROUP=   7 BASE ELEMENT IN ARRAY SPRO=   0
SLOPE GROUP=   2 NO. OF SLOPES IN GROUP=   4 BASE ELEMENT IN ARRAY SPRO=   7


ESTABLISH SOIL PROPERTY DATA

TOTAL NUMBER OF SLOPE GROUPS                          2
BASE ELEMENT OF FIRST (DEPTH,K) IN SPRO(ARRAY)       11
NUMBER OF DEPTH POINTS WITHIN EACH SOIL COLUMN        3
NUMBER OF SOIL PARAMETERS AT EACH DEPTH POINT         2


NO. OF SOIL TYPES IN GROUP  20 BASE ELEMENT IN SPRO   11 BASE ELEMENT IN KSP   0
NO. OF SOIL TYPES IN GROUP   9 BASE ELEMENT IN SPRO  131 BASE ELEMENT IN KSP  20
KSP( 1) AC
KSP( 2) AD
KSP( 3) BE
KSP( 4) BT
KSP( 5) CA
KSP( 6) CI
KSP( 7) CV
KSP( 8) DP
KSP( 9) EN
KSP(10) GR
KSP(11) HA
KSP(12) HS
KSP(13) HR
KSP(14) LA
KSP(15) LB
KSP(16) MU
KSP(17) NS
KSP(18) PT
KSP(19) RY
KSP(20) VO
KSP(21) BI
KSP(22) EM
KSP(23) FA
KSP(24) JN
KSP(25) MS
KSP(26) MT
KSP(27) OA
KSP(28) PA
KSP(29) TR


CRITERIA FOR SEDIMENT DETENTION PONDS
TEFF=      .900
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LAND SURFACE EROSION DATA

LAND USE	SOIL TYPE CODE	SAMPLE SIZE PERCENT (PAR.)	OVERLAND FLOW DISTANCE FT (XLTH)	GROUND SLOPE PERCENT (SLOPE)	GROUND COVER FACTOR PERCENT (GCOV)	EROSION CONTROL FACTOR PERCENT (ECP)	SOIL ERODIBILITY FACTOR FRACTION (XK)	SEDIMENT DELIVERY RATIO FRACTION (SDR)	COMPUTED LENGTH-SLOPE FACTOR (XLS)
DEFAULT VALUES FOR UNIVERSAL SOIL LOSS EQUATION VARIABLES:		100.000	150.000	0.000	2.000	100.000	0.000	0.000	
LAND USE DATA READ FROM EACH R-CARD IS MERGED WITH SOIL PROPERTIES AND EROSION DEFAULT VALUES AS SHOWN BELOW(1ST LINE = CARD AS READ,2ND LINE = VALUES USED IN COMPUTATIONS)									
R OPEN	RE	5.000	150.000	3.000	2.000	-0.000	.320	1.000	
REQUESTED SOIL TYPE RE NOT IN DATA TABLE. PROGRAM USED K*LS*C*P FROM R-CARD		5.000	150.000	3.000	2.000	100.000	.320	1.000	.3719
R OPEN	LAE	75.000	-0.000	-0.000	-0.000	-0.000	-0.000	.430	
		75.000	150.000	52.500	2.000	100.000	.540	.430	29.1563
R OPEN	BTB	10.000	-0.000	-0.000	-0.000	-0.000	-0.000	.640	
		10.000	150.000	8.000	2.000	100.000	.340	.640	1.2081
R SINGLE	LBB	40.000	100.000	-2.000	-0.000	-0.000	-0.000	.700	
MAXIMUM DEPTH OF CUT IN FEET= 6.00		40.000	100.000	2.000	2.000	100.000	.545	.700	.2124
R SINGLE	LBB	60.000	100.000	2.000	-0.000	-0.000	-0.000	.500	
MAXIMUM DEPTH OF CUT IN FEET= 6.00		60.000	100.000	2.000	2.000	100.000	.545	.500	.2124
R NONURB	BEB	20.000	150.000	-0.000	-0.000	-0.000	-0.000	.100	
		20.000	150.000	8.000	2.000	100.000	.300	.100	1.2081
R NONURB	VUE	15.000	150.000	-0.000	-0.000	-0.000	-0.000	.100	
		15.000	150.000	52.500	2.000	100.000	.280	.100	29.1563
R NONURB	PHC	5.000	150.000	-0.000	-0.000	-0.000	-0.000	.100	
		5.000	150.000	5.500	2.000	100.000	.500	.100	.7317

END OF LAND USE AND SOIL EROSION DATA

AVE LAND SURF EROSION AND SEDIMENT DELIVERY

LAND USE	AREA IN ACRES	PERCENT OF AREA SAMPLED	POTENTIAL LAND SURF EROSION FACTOR	SEDIMENT DELIVERY RATIO FRACTION
SINGLE	42.0	100.000	.002	.500
OPEN	378.0	90.000	.263	.485
NONURB	180.0	40.000	.057	.100

1 TREATMENT RATE(S) WILL BE INVESTIGATED

TREATMENT RATE (IN/HR)	NO. OF STORAGES	NO. OF POLLUTOGRAPHS	PLOT	PRINT	TAPES	REMARK
.0100	1	1	0	3	0	0

STORAGES TO BE USED WITH ABOVE TREATMENT RATE (INCHES) .100

STORM POLLUTOGRAPHS WILL BE PRINTED FOR THESE EVENTS: 29

STORM EROSION WILL BE PRINTED FOR THESE EVENTS: 1

22

7	15	18	21

QUANTITY ANALYSIS

TREATMENT RATE = .0100 IN/HR, 6.0 CFS, 3,910 MGD
STORAGE CAPACITY= .1000 INCHES, 5.0 AC-FT, 1,630 MG

WEATHER BUREAU, BOISE AIRPORT
BOISE HEIGHTS

EVENT	BEGIN YEAR	MO	DY	HR	HRS STORAG	DURTN HRS	RAINFALL QUANTY	MAX INTENS INCHES	HRS TO EMPTY	STORAGE DURTN	MAX	OVERFLOW NO	OVERFLOW ST	OVERFLOW DUR	OVERFLOW WASTE	OVERFLOW TOTL	TREATMENT HRS	TREATMENT CANTY	AGE OF STORAGE AGE1	AGE2	AGE3	AGE4	AGE5
*1	*2	*3	*4	*5	*6	*7	*7A	*8	*9	*10	*11	*12	*13	*14	*15	*16	*17	*18	*19	*20	*21	*22
1	72	1	9	10	272	8	8	.43	.11	3	11	.02		8	NO OVERFLOW		15	.12	1.4	4.5	9.1	3.1	3.6
2	72	1	11	7	34	4	4	.21	.05	2	6	.01		2	NO OVERFLOW		15	.10	1.1	3.5	3.7	1.4	1.5
3	72	1	18	5	160	11	10	.57	.14	4	15	.03		11	NO OVERFLOW		26	.18	1.5	4.6	13.5	3.1	4.6
4	72	1	20	4	32	2	2	.19	.02	1	3	0.00		1	NO OVERFLOW		4	.03	.6	1.5	1.5	.9	.9
5	72	1	20	10	3	2	2	.15	.04	2	4	.01		2	NO OVERFLOW		6	.04	.9	2.0	2.5	1.2	1.2
6	72	1	20	16	-	0	0	.15	.09	3	9	.03		5	NO OVERFLOW		10	.09	1.7	4.1	6.6	2.4	2.8
7	72	1	21	4	5	1	1	.07	.02	1	2	0.00		1	NO OVERFLOW		5	.03	.5	.5	.5	.5	.5
8	72	1	21	22	12	15	12	.66	.14	2	17	.05		6	NO OVERFLOW		18	.14	2.6	8.5	15.5	4.4	5.6
9	72	1	23	3	12	3	3	.12	.03	1	4	.01		1	NO OVERFLOW		9	.06	.9	2.5	2.5	1.0	1.0
10	72	2	15	12	557	3	3	.15	.04	1	4	0.00		3	NO OVERFLOW		10	.05	.5	1.9	1.9	1.3	1.3
11	72	2	27	8	248	2	2	.07	.02	0	2	0.00		1	NO OVERFLOW		11	.05	.5	.5	.5	.5	.5
12	72	2	28	5	19	3	3	.25	.06	2	7	.03		3	NO OVERFLOW		10	.08	1.6	4.3	5.5	1.8	2.0
13	72	2	28	23	11	1	1	.10	.04	1	5	.03		1	NO OVERFLOW		6	.05	1.0	3.5	3.5	1.2	1.2
14	72	2	29	7	3	2	2	.18	.02	0	2	0.00		1	NO OVERFLOW		2	.01	.5	.5	.5	.5	.5
15	72	3	2	2	41	4	4	.19	.05	1	5	.01		3	NO OVERFLOW		6	.05	.6	1.7	2.5	1.3	1.5
16	72	3	2	10	3	8	8	.37	.19	13	18	.10	1	8	1	0.00	0.00	19	.18	3.7	12.4	14.6	4.3	5.2
17	72	3	10	11	367	7	7	.37	.17	13	17	.10	2	7	1	0.00	0.00	21	.17	4.4	12.0	15.3	4.4	5.7
18	72	4	11	21	589	1	1	.18	.02	2	3	.01		1	NO OVERFLOW		6	.02	.6	1.5	1.5	.6	.6
19	72	4	12	17	17	3	3	.14	.03	0	3	0.00		1	NO OVERFLOW		3	.02	.6	1.5	1.5	.9	.9
20	72	4	16	11	67	2	2	.15	.03	1	3	0.00		2	NO OVERFLOW		4	.02	.5	.9	.9	.8	.8
21	72	5	21	21	847	1	1	.14	.01	1	2	0.00		1	NO OVERFLOW		7	.03	.5	.5	.5	.5	.5
22	72	6	6	14	375	2	2	.19	.07	6	8	.05		1	NO OVERFLOW		8	.07	3.0	6.5	6.5	2.3	2.3
23	72	6	7	19	21	4	4	.19	.07	4	8	.03		4	NO OVERFLOW		8	.07	1.6	3.5	6.5	1.8	2.2
24	72	6	9	24	45	2	2	.21	.04	2	4	.02		1	NO OVERFLOW		7	.05	1.1	2.5	2.5	1.2	1.2
25	72	7	21	14	948	2	2	.29	.05	3	5	.03		1	NO OVERFLOW		5	.04	1.0	3.5	3.5	1.5	1.5
26	72	9	5	6	1057	3	3	.14	.03	0	3	0.00		1	NO OVERFLOW		6	.03	.6	1.5	1.5	.7	.7
27	72	9	5	15	6	2	2	.33	.08	7	9	.06		2	NO OVERFLOW		10	.09	3.3	6.5	7.5	2.6	2.7
28	72	9	11	8	128	6	6	.23	.05	3	6	.03		1	NO OVERFLOW		8	.06	2.0	4.5	4.5	1.7	1.7
29	72	9	15	5	47	18	18	1.07	.45	9	27	.10	3	-	8	.1A	.07	31	.28	5.5	10.5	25.5	8.0	8.7
30	72	9	27	3	259	2	2	.18	.02	0	2	0.00		1	NO OVERFLOW			5	.03	.5	.5	.5	.5	.5
31	72	9	27	6	1	2	2	.19	.05	3	5	.02		2	NO OVERFLOW			5	.04	1.3	2.5	3.5	1.3	1.6
32	72	10	9	19	296	7	5	.38	.07	0	7	.03		2	NO OVERFLOW			8	.07	1.5	4.5	5.5	1.5	1.7
33	72	10	19	15	229	5	4	.26	.06	1	6	.01		2	NO OVERFLOW			9	.06	.8	4.2	4.3	1.9	1.9
34	72	11	4	7	370	2	2	.10	.06	3	5	.02		2	NO OVERFLOW			11	.06	1.1	2.5	3.5	1.0	1.2
35	72	11	4	19	7	2	2	.19	.05	3	5	.02		2	NO OVERFLOW			5	.04	1.1	2.5	3.5	1.2	1.4
36	72	11	8	4	76	6	5	.33	.07	1	7	.01		2	NO OVERFLOW			9	.07	1.1	2.5	5.5	1.8	2.5
37	72	11	18	21	253	1	1	.14	.02	1	2	0.00		1	NO OVERFLOW			12	.03	.5	.5	.5	.5	.5
38	72	11	20	11	180	2	2	.15	.01	0	2	0.00		1	NO OVERFLOW			8	.03	.5	.5	.5	.5	.5
39	72	12	15	10	525	12	11	.73	.17	6	18	.07		7	NO OVERFLOW			20	.14	3.3	8.5	10.5	4.7	6.1
40	72	12	19	7	3	13	11	.94	.23	9	22	.10	4	9	2	.02	.02	24	.21	4.6	12.5	18.5	5.4	6.4
41	72	12	22	15	58	2	2	.11	.03	1	3	0.00		2	NO OVERFLOW			7	.04	.5	1.0	1.0	.8	.8
42	72	12	23	23	29	7	7	.31	.08	1	8	.03		2	NO OVERFLOW			9	.08	1.5	5.5	6.5	2.3	2.6
AVE OF 42 EVENTS					199.2**	4.5	4.2	.12	.07	2.7	7.2	.03		2.4*				10.2	.06	1.5	3.9	5.5	1.9	2.2
AVE OF 4 OVRFLW EVENTS					11.5	11.0	1.12	.26	9.5	21.0	.02*			8.0	3.0	.04	.03	23.8	.22	4.5	12.8	18.5	5.8	6.5

* NON-OVERFLOW EVENTS ONLY.
**EXCLUDING 0 DRY PERIODS

AVERAGE ANNUAL STATISTICS FOR 1 YEARS OF RECORD FOR THE PERIOD BEGINNING 720102 AND ENDING 721228

NUMBER OF EVENTS = 42.0

NUMBER OF OVERFLOWS = 4.0

	INCHES	
TOTAL PRECIPITATION IN WATERSHED	18.67	
TOTAL RUNOFF FROM WATERSHED	3.66	FRACTION OF RAINFALL = .20
OVERFLOW TO RECEIVING WATER	.23	FRACTION OF RAINFALL = .01, OF RUNOFF = .06
INITIAL OVERFLOW TO RECIEVING WATER	.12	FRACTION OF RAINFALL = .01, OF RUNOFF = .03

DEFINITIONS OF QUANTITY COLUMN HEADINGS

1 EVENT = SEQUENCING NUMBER.
2 DATE = DATE THIS EVENT BEGAN.
3 HR = NUMBER OF HOURS PAST MIDNIGHT THIS EVENT BEGAN.
4 HRS NO STORAG = NUMBER OF HOURS SINCE END OF LAST EVENT, EXCLUDING SUMMER (MORE THAN, 1440 HOURS).

5 DURTN = DURATION OF STORM FROM FIRST HOUR OF RAIN TO LAST HOUR OF RAIN.
6 HRS = NUMBER OF HOURS IN WHICH RAINFALL OCCURRED DURING EVENT.
7 QUANTY = AMOUNT OF RAINFALL DURING THE EVENT IN INCHES.
7A RUNOFF INCHES = RUNOFF DURING EVENT IN INCHES.
8 HRS TO EMPTY = NUMBER OF HOURS FROM LAST RAIN FALL TO END OF EVENT.
9 DURTN = TOTAL NUMBER OF HOURS STORAGE WAS UTILIZED. IE, LENGTH OF THE EVENT.
10 MAX = MAXIMUM AMOUNT OF STORAGE UTILIZED, IN INCHES.

11 NO = OVERFLOW EVENT SEQUENCING NUMBER.
12 ST = NUMBER OF HOURS ELAPSED BEFORE OVERFLOW STARTED. OR, IF NO OVERFLOW, HOUR OF MAXIMUM STORAGE.
13 DUR = NUMBER OF HOURS IN WHICH OVERFLOW OCCURRED.
14 WASTE = QUANTITY OF WATER RELEASED UNTREATED, IN INCHES.
15 INITL = QUANTITY OF WATER RELEASED UNTREATED DURING THE FIRST 3 HOURS OF OVERFLOW.

16 HRS = NUMBER OF HOURS WATER WAS TREATED DURING THE PRESENT EVENT AND SINCE THE PREVIOUS EVENT.
17 QANTY = QUANTITY OF WATER TREATED DURING THE EVENT AND SINCE THE PREVIOUS EVENT.
18 AGE1 = AVERAGE AGE (HOURS) OF TREATED RUNOFF.
19 AGE2 = MAXIMUM AGE (HOURS) OF STORAGE ON FIRST IN, FIRST OUT BASIS.
20 AGE3 = MAXIMUM AGE (HOURS) OF STORAGE ON FIRST IN, LAST OUT BASIS.
21 AGE4 = QUANTITY WEIGHTED AVERAGE AGE (HRS) OF STORAGE ON FIRST IN, FIRST OUT BASIS.
22 AGE5 = QUANTITY WEIGHTED AVERAGE AGE (HRS) OF STORAGE ON FIRST IN, LAST OUT BASIS.

Revised Test 2 Quality Analysis

PAGE 1 BOISE, IDAHO URBAN STUDY EXHIBIT TWO

QUALITY ANALYSIS

TREATMENT RATE = .0100 IN/HR, 6.0 CFS, 3.910 MGD
STORAGE CAPACITY= .1000 INCHES, 5.0 AC-FT, 1.630 MG

WEATHER BUREAU, BOISE AIRPORT
BOISE HEIGHTS

EVENT	DATE EVENT BEGAN YR	MO	DY	HR	RAIN FALL INCHS	STORM RUNOFF INCHS QANTY	TOTAL POUNDS SUSP	SETL	BOD	N	PO4	STORAGE OVERFLOW SEQ NO	INCHS QANTY	SUSP	TOTAL POUNDS SETL	BOD	N	PO4	FIRST 3 HOURS OVERFLOW INCH Q	TOTAL POUNDS SUSP	SETL	BOD	N	PO4
1	72	1	9	10	.43	.11	14797	3642	2209	371	259		NO OVERFLOW											
2	72	1	11	7	.21	.05	4474	1115	693	112	78		NO OVERFLOW											
3	72	1	18	5	.57	.14	25522	6308	3957	640	446		NO OVERFLOW											
4	72	1	20	4	.09	.02	3334	831	517	84	58		NO OVERFLOW											
5	72	1	20	10	.15	.04	4423	1102	685	111	77		NO OVERFLOW											
6	72	1	20	18	.35	.09	7518	1872	1164	189	131		NO OVERFLOW											
7	72	1	21	6	.07	.02	1148	286	178	29	20		NO OVERFLOW											
8	72	1	21	22	.66	.16	7962	1960	1232	200	139		NO OVERFLOW											
9	72	1	23	3	.12	.03	1058	263	164	27	18		NO OVERFLOW											
10	72	2	15	12	.15	.04	9586	2390	1492	241	167		NO OVERFLOW											
11	72	2	27	8	.07	.02	5715	1426	888	144	100		NO OVERFLOW											
12	72	2	28	5	.25	.06	17602	4392	2729	443	307		NO OVERFLOW											
13	72	2	28	23	.16	.04	9119	2284	1411	230	159		NO OVERFLOW											
14	72	2	29	7	.08	.02	3910	974	606	98	66		NO OVERFLOW											
15	72	3	2	2	.19	.05	8873	2209	1375	223	155		NO OVERFLOW											
16	72	3	2	10	.77	.19	19708	4885	3045	498	342	1	0.00	621	154	96	16	11	0.00	621	154	96	16	11
17	72	3	18	11	.77	.17	17528	4334	2717	445	304	2	0.00	232	57	36	6	4	0.00	232	57	36	6	4
18	72	4	11	21	.18	.02	2894	710	453	75	50		NO OVERFLOW											
19	72	4	12	17	.18	.03	7937	1975	1233	200	138		NO OVERFLOW											
20	72	4	16	11	.15	.03	5028	1245	762	128	87		NO OVERFLOW											
21	72	5	21	21	.04	.01	3370	838	525	85	59		NO OVERFLOW											
22	72	6	6	14	.39	.07	31156	7666	4830	793	540		NO OVERFLOW											
23	72	6	7	19	.39	.07	24186	6040	3746	611	421		NO OVERFLOW											
24	72	6	9	24	.21	.04	9769	2415	1509	248	169		NO OVERFLOW											
25	72	7	21	18	.29	.05	34190	8540	5307	862	596		NO OVERFLOW											
26	72	9	5	6	.14	.03	15625	3867	2438	395	273		NO OVERFLOW											
27	72	9	5	15	.33	.08	50552	12559	7835	1275	880		NO OVERFLOW											
28	72	9	11	8	.23	.05	23550	5852	3647	594	410		NO OVERFLOW											
29	72	9	15	5	1.97	.45	61683	15421	9561	1542	1079	3	.18	5105	1276	791	128	89	.07	4004	1016	630	102	71
30	72	9	27	3	.06	.02	61	0	11	3	1		NO OVERFLOW											
31	72	9	27	6	.19	.05	165	14	24	8	1		NO OVERFLOW											
32	72	10	9	19	.38	.07	10793	2650	1673	277	186		NO OVERFLOW											
33	72	10	19	15	.26	.06	7993	1967	1237	208	138		NO OVERFLOW											
34	72	11	4	7	.16	.04	4760	1165	737	122	82		NO OVERFLOW											
35	72	11	4	19	.19	.05	4604	1125	710	118	79		NO OVERFLOW											
36	72	11	8	4	.33	.07	8096	1990	1251	207	140		NO OVERFLOW											
37	72	11	18	21	.08	.02	2973	736	461	75	52		NO OVERFLOW											
38	72	11	20	11	.05	.01	2136	528	331	54	37		NO OVERFLOW											
39	72	12	18	10	.73	.17	17644	4368	2732	455	303		NO OVERFLOW											
40	72	12	19	7	.94	.23	9480	2265	1444	250	160	*	.02	815	191	123	22	14	.02	815	191	123	22	14
41	72	12	22	15	.11	.03	1652	405	255	42	28		NO OVERFLOW											
42	72	12	23	23	.31	.08	4709	1155	725	121	81		NO OVERFLOW											
AVE OF	42	EVNTS			.32	.07	12078	2995	1872	305	210													
AVE OF	4	OVRFLS			1.12	.26	27099	6726	4192	684	471		.06	1093	420	262	43	29	.03	1433	355	221	36	25

AVERAGE ANNUAL STATISTICS FOR 1 YEARS OF RECORD FOR THE PERIOD BEGINNING 720102 AND ENDING 721228

	SUSP	SETL	BOD	N	PO4
TOTAL POUNDS WASHOFF FROM WATERSHED	606103	150334	93973	15302	10524
TOTAL POUNDS OVERFLOW TO RECEIVING WATER	6772	1678	1046	171	117
CONCENTRATION OF POLLUTANTS IN OVERFLOW TO RECEIVING WATER (MG/L)	217,84	53,98	33,65	5,50	3,76
FRACTION OF TOTAL WASHOFF OVERFLOWING TO RECEIVING WATER	.01	.01	.01	.01	.01
FRACTION OF TOTAL WASHOFF INITIALLY OVERFLOWING TO RECEIVING WATER	.01	.01	.01	.01	.01

BOISE, IDAHO URBAN STUDY

EXHIBIT 1AL

POLLUTOGRAPH FOR EVENT

TREATMENT RATE = .0100 IN/HR, 0.0 CFS, 3,910 MGD
STORAGE CAPACITY= .1000 INCHES, 5.0 AC-FT, 1,630 MG

WEATHER BUREAU, BOISE AIRPORT
BOISE HEIGHTS

EVENT	YR	MO	DY	HR	T(0)	RAINFALL	RUNOFF	CFS-OFF	**RUNOFF POLLUTANT LOAD, IN LBS/HR**					** AVE CONCENTRATION, IN MG/L ******				
									SUSP	SETL	BOD	N	PO4	SUSP	SETL	BOD	N	PO4
29	72	9	15	5	1	.05	.01	8.0	9031.5	2257.9	1399.9	225.8	158.1	5023.6	1255.9	778.7	125.59	87.92
29	72	9	15	6	2	.06	.01	9.0	8026.6	2156.7	1337.1	215.7	151.0	4265.4	1006.3	661.1	106.63	74.64
29	72	9	15	7	3	.07	.02	10.0	7983.0	1995.8	1237.4	199.6	139.7	3552.4	888.1	550.6	88.81	62.17
29	72	9	15	8	4	.08	.02	12.0	7753.9	1938.5	1201.9	193.8	135.7	2875.4	716.9	445.7	71.89	50.32
29	72	9	15	9	5	.09	.02	14.0	7046.0	1761.5	1092.1	176.2	123.3	2239.6	559.9	347.1	55.99	39.19
29	72	9	15	10	6	.12	.03	18.0	6667.3	1666.8	1033.4	166.7	116.7	1646.3	412.1	255.5	41.21	28.85
29	72	9	15	11	7	.13	.03	20.0	5141.6	1285.4	796.9	128.5	90.0	1144.0	286.0	177.3	28.60	20.02
29	72	9	15	12	8	.17	.04	25.0	4179.1	1044.8	647.8	104.5	73.1	743.9	186.0	115.3	18.60	13.02
29	72	9	15	13	9	.20	.04	25.0	2469.5	617.4	382.8	61.7	43.2	439.6	109.9	68.1	10.99	7.69
29	72	9	15	14	10	.23	.04	25.0	1326.2	331.5	205.6	33.2	23.2	236.1	59.0	36.6	5.90	4.13
29	72	9	15	15	11	.22	.04	25.0	687.0	171.7	106.5	17.2	12.0	122.3	30.6	19.0	3.06	2.14
29	72	9	15	16	12	.19	.04	25.0	379.7	94.9	58.9	9.5	6.6	67.6	16.9	10.5	1.69	1.18
29	72	9	15	17	13	.15	.04	22.0	205.4	51.3	31.8	5.1	3.6	41.5	10.3	6.4	1.04	.73
29	72	9	15	18	14	.11	.03	16.0	103.2	25.8	16.0	2.6	1.8	25.7	7.2	4.4	.72	.50
29	72	9	15	19	15	.07	.02	10.0	50.1	12.5	7.8	1.3	.9	22.3	5.6	3.5	.56	.39
29	72	9	15	20	16	.03	.01	5.0	21.6	5.4	3.4	.5	.4	19.3	4.8	3.0	.46	.34
29	72	9	15	21	17	.01	.00	2.0	8.1	2.0	1.3	.2	.1	18.0	4.5	2.8	.45	.31
29	72	9	15	22	18	.01	.00	1.0	3.9	1.0	.6	.1	.1	17.5	4.4	2.7	.44	.31

BOISE, I AND URBAN STUDY

EXHIBIT I-J

TREATMENT RATE = .0100 IN/HR, 0.0 CFS, 3,910 MGD
STORAGE CAPACITY= .1000 INCHES, 5.0 AC-FT, 1,630 MG

WEATHER BUREAU, BOISE AIRPORT
BOISE HEIGHTS

EVENT	LAND USE	LAND SURFACE EROSION TONS/ACRE	LAND SURFACE EROSION TONS	WASH-OFF FROM IMPERVIOUS AREA, TONS	DELIVERED TO CHANNEL TONS	DEPOSITED ON IMPERVIOUS AREA TONS	DEPOSITED IN SEDIMENT TRAP, TONS	OUTFLOW FROM STUDY AREA TONS	OUTFLOW FROM STUDY AREA PPM
	SINGLE	.000	.01	.35	.35	.00	.32	.04	53.39
	OPEN	.021	4.03	.65	4.34	0.00	3.91	.43	121.23
1	URBAN TOTAL		8.04	.60	4.70	.00	4.23	.47	116.63
	NONURB	.013	2.36		.24		.21	.02	3.82
	TOTAL		10.41		4.94		4.44	.49	47.12
	SINGLE	.000	.00	.03	.03	.00	.02	.00	24.96
	OPEN	.006	2.22	.03	1.11	0.00	1.00	.11	192.33
7	URBAN TOTAL		2.23	.06	1.15	.00	1.02	.11	166.18
	NONURB	.004	.66		.07		.06	.01	6.61
	TOTAL		2.89		1.20		1.08	.12	71.30
	SINGLE	.000	.00	.27	.27	.00	.24	.03	90.11
	OPEN	.013	4.86	.34	2.70	0.00	2.43	.27	166.71
15	URBAN TOTAL		4.86	.61	2.97	.00	2.67	.30	154.83
	NONURB	.008	1.43		.14		.13	.01	5.10
	TOTAL		6.30		3.11		2.80	.31	65.79
	SINGLE	.000	.01	.16	.16	.00	.15	.02	123.17
	OPEN	.037	14.13	.20	7.05	0.00	6.35	.71	984.35
18	URBAN TOTAL		14.15	.36	7.22	.00	6.50	.72	849.79
	NONURB	.021	3.72		.37		.33	.04	29.66
	TOTAL		17.87		7.59		6.83	.76	362.65
	SINGLE	.000	.00	.24	.24	.00	.21	.02	371.31
	OPEN	.010	3.70	.30	2.10	0.00	1.89	.21	606.69
21	URBAN TOTAL		3.70	.54	2.34	.00	2.10	.23	508.39
	NONURB	.002	.36		.04		.03	.00	5.96
	TOTAL		3.06		2.37		2.13	.24	233.96
	SINGLE	.001	.00	1.82	1.86	.01	1.67	.19	409.35
	OPEN	.100	60.32	2.34	31.60	0.00	28.44	3.16	1289.51
22	URBAN TOTAL		60.35	4.17	33.46	.01	30.11	3.35	1151.99
	NONURB	.095	17.04		1.70		1.53	.17	40.01
	TOTAL		77.42		35.16		31.64	3.52	690.78

AVERAGE ANNUAL SEDIMENT YIELD FOR PERIOD OF RECORD STUDIED

EVENT	LAND USE	LAND SURFACE EROSION TONS/ACRE	LAND SURFACE EROSION TONS	WASH-OFF FROM IMPERVIOUS AREA, TONS	DELIVERED TO CHANNEL TONS	DEPOSITED ON IMPERVIOUS AREA TONS	DEPOSITED IN SEDIMENT TRAP, TONS	OUTFLOW FROM STUDY AREA TONS	OUTFLOW FROM STUDY AREA PPM
	SINGLE	.014	.59	31.413	31.76	.07	28.58	3.18	
	OPEN	1.012	609.35	42.432	337.97	0.00	304.17	33.80	
	NONURB	1.025	184.48	0.000	16.44	0.00	16.60	1.84	
	TOTAL		794.38	73.84	348.17	.07	349.35	38.82	

AVERAGE ANNUAL RAINFALL AND SNOWMELT ENERGY FOR URBAN AREA = 0.12
NONURBAN AREA = 17.94

EXHIBIT 3

INPUT DATA DESCRIPTION

Each input card is described in detail below. Variable locations on each card are shown by field number. Most cards are divided into ten fields of eight columns each except field 1. Variables occurring in field 1 may only occupy card columns 3-8 because card columns 1 and 2 are reserved for the card identification alphanumeric character. The card identification characters will be referred to as field zero. Cards with a different format are so noted.

The different values a variable may assume and the conditions for each are described for each variable. Some variables simply indicate whether a program option is to be used or not by using the numbers -1, 0, 1, etc. Other variables contain numbers which express the magnitude of the variable. For these, a plus sign (+) is shown in the description under "value" and the numerical value of the variable is entered as input. Where the variable value is to be zero, the corresponding field may be left blank because a blank field is read as zero. A value of "AN" refers to alphanumeric characters.

a. A Cards (three cards required)

Three title cards A1, A2, and A3 for output title.

Field	Variable	Value	Description
0		A1	Card identification in columns 1 and 2.
1-10	NTITLE	AN	Job title information, preferably centered in columns 3-80.
			Third title card will be used as a heading on each output page.

b. B Cards (two cards required)

Job specification cards.

B1 Card (required)

Field	Variable	Value	Description
0		B1	Card identification.
1	NWSHD	+	Number of watersheds to be analyzed. Calls for NWSHD sequences of E through T cards as required. Default = 1.
2	ISNO	0	No snowmelt computations are desired. Omit D cards.
		1	Snowmelt computations are to be made using D cards.
3	NONURB	0	Nonurban watershed computations will not be made. Omit H, J, and K cards.
		1	Nonurban watershed computations will be performed using H, J, and K cards as required.
4	ISED	0	No land surface erosion computations will be made. Omit * through R cards.
		1	Land surface erosion computations will be made using * through R cards.
5	IQUAL	0	No water quality computations will be made. F2 cards are still required even though blank.
		1	Water quality computations will be made.
6	IEVNT	0	No detailed analysis (pollutograph) of selected events is desired. IPOLMX (T2-3) will be zero.
			Detailed event analysis will be required, IPOLMX (T2-3) may be greater than zero.

B2 Card (required)

Climatic data.

Field	Variable	Value	Description
0		B2	Card identification
1	NSUMR	+	Length, in days, of average summer (period of no rain), default = 42.
2	LEXT	+	Number of initial hours of overflow for which separate quantity and quality reporting is desired (default = 3).
3	LINE	+	Number of years of rainfall represented on rainfall record (default = computed value).
4	LDATE	+	Date (YR, MO, DY) of the end of rainfall for the last major precipitation preceding the first rainfall record. Six columns right justified. (default = 6 days).
		-	Number of days since the end of rainfall from last precipitation preceding the first rainfall record. (Default = 6)
5	LHR	+	Hour of last major precipitation preceding the rainfall record. (Default = midnight)

c. C Cards

Precipitation data.

C1 Card (required)

Field	Variable	Value	Description
0		C1	Card identification.
1-4	NAME	AN	Title of precipitation record, columns 3-32 inclusive.
5	IN	5	Precipitation data is to be supplied on C2 cards.
		+	Unit number for precipitation data tape/disk. No C2 cards are read. Format is same as on C2 card.
		-	Previously generated unformatted binary tape/disk rainfall/snowmelt records will be used on FORTRAN logical unit 12. Omit C2 and D cards. This is a time saving option in that the basic precipitation and temperature data need only be processed once. Upon generation of a satisfactory rainfall/snowmelt file, the tape/disk on logical unit 12 should be saved for future use under this option.
6	IFILE	+	Number of tape files to be skipped in order to reach precipitation records. Used only if data is read from tape.
7	ISTART	+	Date (six digit integer for year, month and day) of first precipitation record to be analyzed. Default equals first day of the precipitation record. Can be used to start analysis at any point in a precipitation record.
8	IEND	+	Date of the last precipitation record to be analyzed. Default equals last day in the precipitation record. Not to be used if input precipitation data is on cards.
9	IR	0	Input precipitation (snowmelt) record will not be output on printer.
		1	Print input precipitation record.

c. C2 Card (Required only if IN(C1-5) is 5). Format (2X, I6, 24I3).

Field	Variable	Value	Description
0		C2	Card identification.
1	KDATE	+	Date of rainfall data on this card. Year, month and day specified in six columns: 3-4, year number; 5-6, month number; 7-8, day number.
2-25	KRAIN	+	Hourly rainfall in hundredths of an inch per hour specified in 24 three-column fields.

Repeat one C2-card for each day of rainfall. A blank C2-card must follow the last day of rainfall.

d. D Cards (two cards required only if ISNO (B1-2) is greater than zero).

Snowmelt parameters.

D1 Card (Required only if ISNO (B1-2) is greater than zero).

Field	Variable	Value	Description
0		D1	Card identification.
1	ITAPE	+	Input unit for temperature data.
2	IFILE	+	Number of files to be skipped to reach file in which starting record occurs.
3	IFREZ	+	Temperature (integer) below which snow falls and above which snow melts.
4	IPACK	+	Starting snowpack water equivalent over basin in hundredths of an inch.
5	ITMP	0	Average temperatures are on D3 card.
		1	Max/Min temperatures are on D3 card.
6	COEF	+	Degree-day melt rate coefficient. Default = .07.

D2 Card (Required only if ISNO (B1-2) is greater than zero).

Daily temperature data in Weather Bureau format (5X, I6, 2I3, 55X, I3). Only Max/Min or average temperatures are necessary as indicated by ITMP (D1-5).

Field	Variable	Value	Description
0		D3	Card identification or station identification in Cols. 1 through 5.
1	JDATE	+	Date, integer, six digits for year, month and day in Cols. 6 through 11.
2	IMAX	+	Maximum daily temperature, °F, Cols. 12-14.
3	IMIN	+	Minimum daily temperature, °F, Cols. 15-17.
4	ITEMP	+	Average daily temperature, °F, Cols. 72-74.

D2 cards are repeated for each month for the period of analysis. All days of the month are to be included even for the last month.

e. E Cards (required)

E through T cards (as required) are repeated for each watershed. The previous rainfall (snowmelt) pattern, KRAIN as modified by snow routine, will be used for each watershed.

E1 Card (required)

Field	Variable	Value	Description
0		E1	Card identification.
1-2	NAMEWS	AN	Title of watershed.
3	MXLG	+	Number of land use groups modeled (Max = 5). MXLG pairs of F1, F2 cards will be read for land uses as defined on F1 card.
4	EXPTE	+	Exponent for dust and dirt washoff, equation (7) in text: $M_p = P_c\ (1 - e^{-EXPTE*\Delta t})/\Delta t$ *Default = 4.6
5	REFF	+	Street sweeping efficiency (ratio of material picked up to the total material on the street) as a decimal fraction (default = 0.70).

E2 Card (Required)

Field	Variable	Value	Description
0		E2	Card identification.
1	AREA	+	Total urban area, in acres, of the watershed.
2	CPERV	+	Runoff coefficient for pervious areas (default = .15).
3	CIMP	+	Runoff coefficient for impervious areas (default = .90).
4	RFU	+	Factor by which KRAIN, rainfall array, is multiplied to obtain average rainfall over urban area.
5	IQU	0	No hydrographs are to be input on G cards.
		1	Hydrographs will be read on G cards and be used to override computed runoff during periods indicated.
6	DVU	+	Minimum flow (cfs) above which flow from the urban area is diverted (default=no diversion).
7	DVUMX	+	Maximum flow (cfs) above which all additional flow is diverted.
8	WU	+	Proportion of available flow between DVUMX and DVU that is diverted.

E3 Cards (two cards required)

Initial loss rate and recovery data.

Field	Variable	Value	Description
0		E3	Card identification.
1	DEPRS	+	Depression storage, average over total watershed, in inches.
2	RECVRT	+	Potential evaporation rate, inches/day (for recovery of depression storage) for January.
3	RECVRT	+	Evaporation rate for February. Continue similarly for March through December.

f. F Cards (two cards required for each land use)

F1 Card (required)

Land use data. F1, F2 card pairs are repeated for each of NXLG (E1-3).

Field	Variable	Value	Description
0		F1	Card identification.
1	LNDUSE	SINGLE	Single family dwellings.
		MULTPL	Multiple family dwellings.
		COMMCL	Commercial development.
		INDSTL	Industrial development.
		OPEN--	Open or park area. Nonurban land use is described separately on H cards.
2	PRCNT	+	Percent of urban watershed area (card E2-1) in this land group.
3	FIMP	+	Percent imperviousness of this land group.
4	STLEN	+	Length of street gutters in feet per acre.
5	NCLEAN	+	Number of days between street sweeping in each land use group (see Note 1 for default value).

F2 Card (required)

Pollutant accumulation and contents. See Note 1.

Field	Variable	Value	Description
0		F2	Card identification.
1	DD	+	Daily rate of accumulation of dust and dirt in pounds per 100 feet of gutter. See Note 1 for default value.
2	FRACTN(L, 1)	+	Pounds of suspended solids per 100 pounds of dust and dirt (see note 1 for default value).
3-6	FRACTN(L, 3-6)	+	Pounds of settleable solids, BOD, Nitrogen and orthophosphate respectively per 100 pounds of dust and dirt. See Note 1 for default values.

g. G Cards (Required only if IQU (E2-5) is greater than zero).

Direct input urban hydrograph data.

G1 Card

Field	Variable	Value	Description
0		G1	Card identification.
1	A	+	Transformation factor "A" for the input urban hydrograph, QU, (G2-3) according to the following equation: QU = A + B*QU
2	B	+	Urban hydrograph transformation factor B.

G2 Card

Field	Variable	Value	Description
0		G2	Card identification.
1	IDQU	+	Station identification, integer.
2	IDATE	+	Date, integer, of flow to be input. Must correspond to a date in the rainfall/ snowmelt array.
3	QU(1)	+	Average flow during first hour of day IDATE.
4	QU(2)	+	Average flow during second hour of day IDATE.
5-10	QU	+	Average flow during hours 3-8. Following two G2 cards have same format for hours 9-16 and 17-24 respectively. G2 cards are repeated for all days for which flow is to be input. A blank card ends the G2 card sequence. Maximum of 100 days in ascending sequence.

h. H Cards (required only if NONURB, B1-3, is greater than zero).

Nonurban watershed data.

H1 Card

Field	Variable	Value	Description
0		H1	Card identification.
1	AREAN	+	Area of nonurban part of watershed in acres.
2	CN	+	Runoff coefficient for nonurban area; water excess will be multiplied by this factor in order to determine runoff.
3	RFN	+	Factor by which KRAIN, rainfall array, is multiplied to obtain average rainfall/ snowmelt over nonurban area.
4	IQN	0	No hydrographs are to be input on K cards.
		1	Hydrograph(s) are to be input on K cards.
5	DVN	+	Minimum flow (cfs) above which flow from the nonurban area is to be diverted. (Default = no diversion).
6	DVNMX	+	Maximum flow (cfs) from nonurban area, above which no additional flow can be diverted.
7	WN	+	Fraction of available flow that is actually diverted.
8	EXPTN	+	Exponent for pollutant washoff from nonurban area. Similar to EXPTE (E1-5) for the urban area. Default = 4.6.

H2 Cards

Field	Variable	Value	Description
0		H2	Card identification.
1	DEPRN	+	Depression storage, in inches, over nonurban area.
2	RECVN(1)	+	Potential evaporation rate, inches/ day (for recovery of nonurban depression storage) for January.
3	RECVN(2)	+	Potential evaporation rate for February. Continue similarly for March through December on this and next H2 card.

i. J Card (required only if H cards are used)

Pollutant accumulation on nonurban area of the watershed. See Note 2 for suggested values. There are no defaults for these variables.

Field	Variable	Value	Description
0		J1	Card identification.
1	POL(1)	+	Pollutant accumulation rate for suspended solids in lbs/acre/day.
2-5	POL(2)	+	Pollutant accumulation rate for settleable solids in lbs/acre/day. Similarly for BOD, total nitrogen and orthophosphate, PO_4.

j. K Cards (Required only if IQN, H1-4, is greater than zero)

Direct input nonurban hydrograph data.

K1 Cards

Field	Variable	Value	Description
0		K1	Card identification.
1	A	+	Transformation factor "A" for the input nonurban hydrograph, QN, (K2-3), according to the following equation: $QN = A + B*QN.$
2	B	+	Nonurban transformation factor B.

K2 Cards

Field	Variable	Value	Description
0		K2	Card identification.
1	IDQN	+	Station identification, integer.
2	NDATE	+	Date, integer, of flow to be input. Must correspond to a date on rainfall/snowmelt record.
3	QN(1)	+	Average flow during first hour of day NDATE.
4-10	QN(2)	+	Average flow during second hour of day NDATE, and for following hours 3-8. Following two K2 cards have same format for hours 9-16 and 17-24 respectively. K2 cards are repeated for all days for which flow is to be input. A blank card ends the K2 card sequence.

Cards * through R form the input data set for calculating land erosion. The data set is divided between cards describing the soil characteristics under natural conditions - this would be * through P4 and the construction and land use requirements to develop the site described on cards Q and R.

k. * Card

Comment cards. To describe and identify the land surface erosion data. Use as many as are needed.

Field	Variable	Value	Description
0		*	Card identification.
1-10			Any α-numeric data that is required to identify and describe the soil erosion analysis. If more than one card is required, show again the * in column 1 and title information across that card, continuing until all the title information is entered.

1. P Card

Soil series identification.

Field	Variable	Value	Description
0	ICG	P	Card identification.
1-10			α-numeric description of the soil series identification by slope and soil type.

P1 Card

Job parameters.

Field	Variable	Value	Description
0	ICG	P1	Card identification.
3	MDS	+	Maximum number of depths in the soil column. P4-card soil properties are identified at MDS depths beneath the ground surface (default = 3).
4	MPD	+	Maximum number of soil parameters for each depth entry. P4-card shows one parameter "XK" for each depth entry.
5	MCSC	+	Maximum number of characters in the soil classification code (default = 3).
6	MCSG	+	Maximum number of characters in the slope group (default = 1).
7	WF	+	The range of WF is 0 to 1. A 0 value weights the natural ground slope to the minimum value of the soil group. A value of 1 weights the natural ground slope to the maximum value for this soil group (default =.5).
8	RMI	+	Ratio of maximum hourly intensity to the maximum 30 minute intensity. If the maximum 30 minute intensity is available from rainfall tapes, the RMI value is not used (default = 0.8).
9	SMEC	+	Snowmelt erosion coefficient for reduction of erosion related energy (default = .33 of the rainfall value).

P2 Card

Ground Slope Data

Field	Variable	Value	Description
0	ICG	P2	Card identification.
3	NSG	+	Number of the slope group which the following slope values describe.
4	SLOPE	+	SCS designated slopes that describe ground surface slope. All of the soil series identification codes can be divided into two slope groups. Therefore, two P2 cards are required. The distinguishing factor is the rate of change of slope with designations "a" through "e". Express in percent.

P4 Card

Soil properties

Field	Variable	Value	Description
0	ICG	P4	Card identification.
2	KSP	+	Enter the first two digits in the α-numeric code assigned by SCS to identify soil series. Group all soils in the same slope group together. Use as many P4 cards as are required to describe each soil type.
3	NSG	+	The soil type on this card belongs to slope group NSG, reference card P2.
4	DEPTH	+	The depth below the ground surface in inches for which soil properties have been identified.
5	XK	+	Soil-**erodibility** factor (K) in the universal soil-loss equation. Enter one value for each depth and as many depths as MDS on card P1.

P5 Card (Optional)

Changes default values of erosion potential factors.

Field	Variable	Value	Description
0	ICG	P5	Card identification.
1-2			Alpha-numeric description.
3-9			Use same variables as fields 3-9 of R-Card.

m. Q Card

Sediment trap data

Field	Variable	Value	Description
0	ICG	Q	Card identification.
3	TEFF	+	Trap efficiency desired for the sediment detention reservoirs. If none is desired this card may be omitted.

n. R Card

Erosion potential model by land use. The R card data describes potential development by land use as it will impact on sediment erosion potential. Any number of R cards may be utilized. The entire basin may be modeled or a small portion may be selected as a sample and the model constructed for the sample and the sample will be expanded automatically by the program to represent the entire basin.

Field	Variable	Value	Description
0	ICG	R	Card identification.
1-2	ISI	+,A	Two entries are made into the variable ISI array. The first is land use using the land use code as follows:
		SINGLE	Single family units.
		MULTPL	Multiple family units.
		COMMCL	Commercial use.
		INDSTL	Industrial.
		OPEN	Open area, such as parks or non-developed urban area.
		NONURB	Nonurban land which contributes water and sediment runoff to the urban area.
			The second entry in ISI is the soil series identification for the land used. It may come from the table of values entered on Card P4, in which case the slope and soil-erodibility properties can be determined from that table. (Otherwise, these values may be entered on the R card, and depth of cut or fill calculations cannot be made.)

R Card (cont.)

Field	Variable	Value	Description
3	PALU	+	Percent of area in this land use category that has the soil and slope properties to be defined on this R card. PALU values are summed for all R cards specifying the same land use and if this summation is less than 100 percent R cards only sample land use in the basin and that sample will be expanded to include the entire basin by the program.
4	XLTH	+	The length of lot in the direction of the ground slope expressed in feet. This must be an average value for the percent of land use shown on this R. card.
5	XS	+	The lot slope is entered in percent and for those lots sloping away from the street it should be a plus value.
		-	Those lots sloping towards the street can be entered as having a negative slope in percent and will be considered as contributing sediment to the streets or impervious surface system. Use the same technique for impervious areas other than streets.
6	GCOV	+	This is a cropping-management factor in % (see the universal soil loss equation.) Its values are identified in that reference. As used here it is a ground cover factor to ratio erosion from land having vegetation or some other cover to the erosion plot values determined by the equation.
7	ECP	+	The erosion control practice factor (P) in % is included because it is part of the universal soils loss equation. The standard default value in this program is one. A table of factors on contouring or terracing is included.
8	XK	+	This is the soil erodibility factor (K) for the universal soil loss equation. Its value needs to be determined by soils experts.
9	SDR	+	The sediment delivery ratio is a factor that accounts for deposition in the basin between the erosion plot being analyzed and the basin outflow point. A standard default value of 0 for those lots sloping away from street, and one for those lots sloping towards the street or unimpervious area.

o. END Card

After the last R Card, include a card with the word "END" in the first three columns to identify that all sediment yield data has been entered.

p. T Cards

Treatment rate and storage capacity alternative.

T1 Card (required)

Field	Variable	Value	Description
0		T1	Card identification.
1	MAX	+	Number, integer, of treatment rates to be investigated. MAX sets of T2 through T5 cards, as required, will be input, (maximum = 20).

T2 Card (required)

Treatment rate, storage capacity and pollutograph data.

Field	Variable	Value	Description
0		T2	Card identification.
1	TRATER (M)	+	Treatment rate in inches per hour for NX (T2-2) storage capacities.
2	NX	+	Number of storage capacities (on T3 cards) to be used in conjunction with above treatment rate (default = 1, maximum = 20).
3	IPOLMX	+	Number of selected events to be printed as listed by event number on T4 card. If this is used, IEVNT, (B1-6), must be greater than zero.
		0	No selected events.
4	IPLOT	0	Do not plot storage utilization curve.
		1	Plot storage utilization curve.
5	IPRINT	0	Suppress printout of individual events. Only summary information will be printed for quantity and quality analyses.
		1	Print all events for quantity analysis and summary listing for both.
		2	Print all events for quality analysis and summary listing for both.
		3	Print all events and summaries for both quantity and quality.

T2 Card (cont.)

Field	Variable	Value	Description
6	IPRTS	0	Suppress event listing for sediment report.
		1	Print land surface erosion information for each event suppressing breakdown by individual urban land use.
		2	Print complete land surface erosion information for each event.
7	IERDMX	+	Number, integer, of events for which complete land surface erosion information is required. Not used if IPRTS is 1 or 2. Maximum of 20. Event numbers are specified on T5 cards.

T3 Card (required)

Storage capacities.

Field	Variable	Value	Description
0		T3	Card identification.
1	CAPR(M,1)	+	Storage capacity in inches for first of NX (T2-2) storages to be analyzed.
2	CAPR(M,2)	+	Storage capacity in inches for second storage to be analyzed. This and the remaining storages are to be entered in successive fields.

T4 Card (required if IPOLMX (T2-3) > 0)

Event numbers for pollutographs.

Field	Variable	Value	Description
0		T4	Card identification.
1	IPOLUT(1)	+	Event number of first of IPOLMX (T2-3) selected events to be printed.
2	IPOLUT(2)	+	Event number of second selected event to be printed. This and remaining events are to be entered in successive fields.

T5 Card (required if IERDMX (T2-7) > 0)

Event numbers for printing of land surface erosion data.

Field	Variable	Value	Description
0		T5	Card identification.
1	IERD(1)	+	Event number of first of IERDMX (T2-7) selected events for which land surface erosion data is to be printed.
2	IERD(2)	+	Event number for second selected event. Similarly for remaining events.

NOTE 1

Defaults* for quality data are as follows:

Variable Name	NCLEAN (F1-5)	DD (F2-1)*		FRACTN (F2-3, 7)*			
	Sweeping	DD rate		Lbs Pollutant/100 lbs DD			
Land Use	Interval, Days	lb/dy/100 ft	SUS	SET	BOD	NIT	PO_4
Single Family Res.	90.0	.7	11.1	1.1	.500	.048	.005
Multiple Family Res.	90.0	2.3	8.0	.8	.360	.061	.005
Commercial	90.0	3.3	17.0	1.7	.770	.041	.007
Industrial	90.0	4.6	6.7	.7	.300	.043	.003
Open or Park	90.0	1.5	11.1	1.1	.500	.048	.005

* Data obtained from American Public Works Association, "Water Pollution Aspects of Urban Runoff," Water Pollution Control Research Series, Federal Water Pollution Control Administration, Report No. WP-20-15, January 1969.

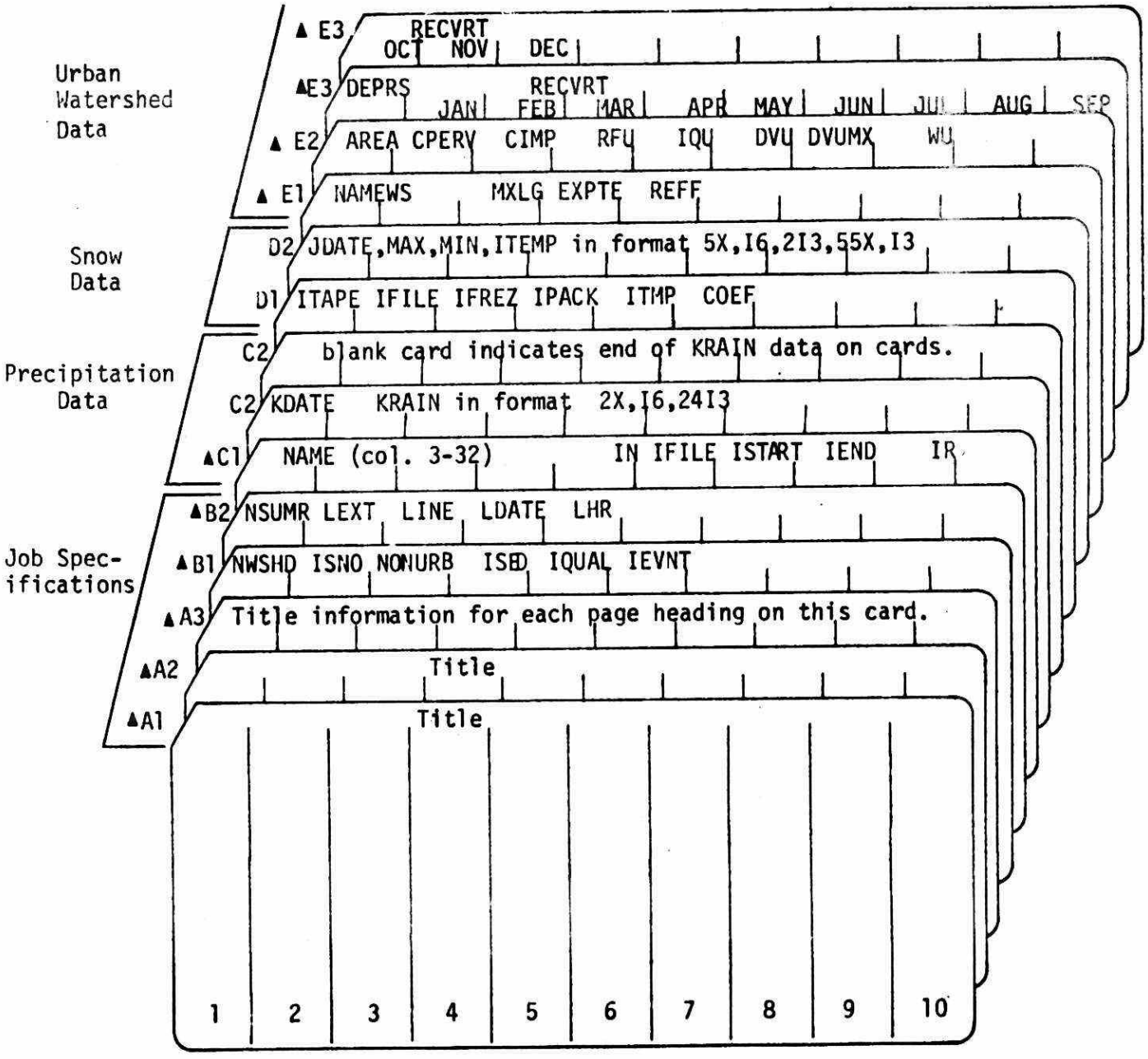
NOTE 2

Suggested* Values for Nonurban Pollutant Loading Rates:

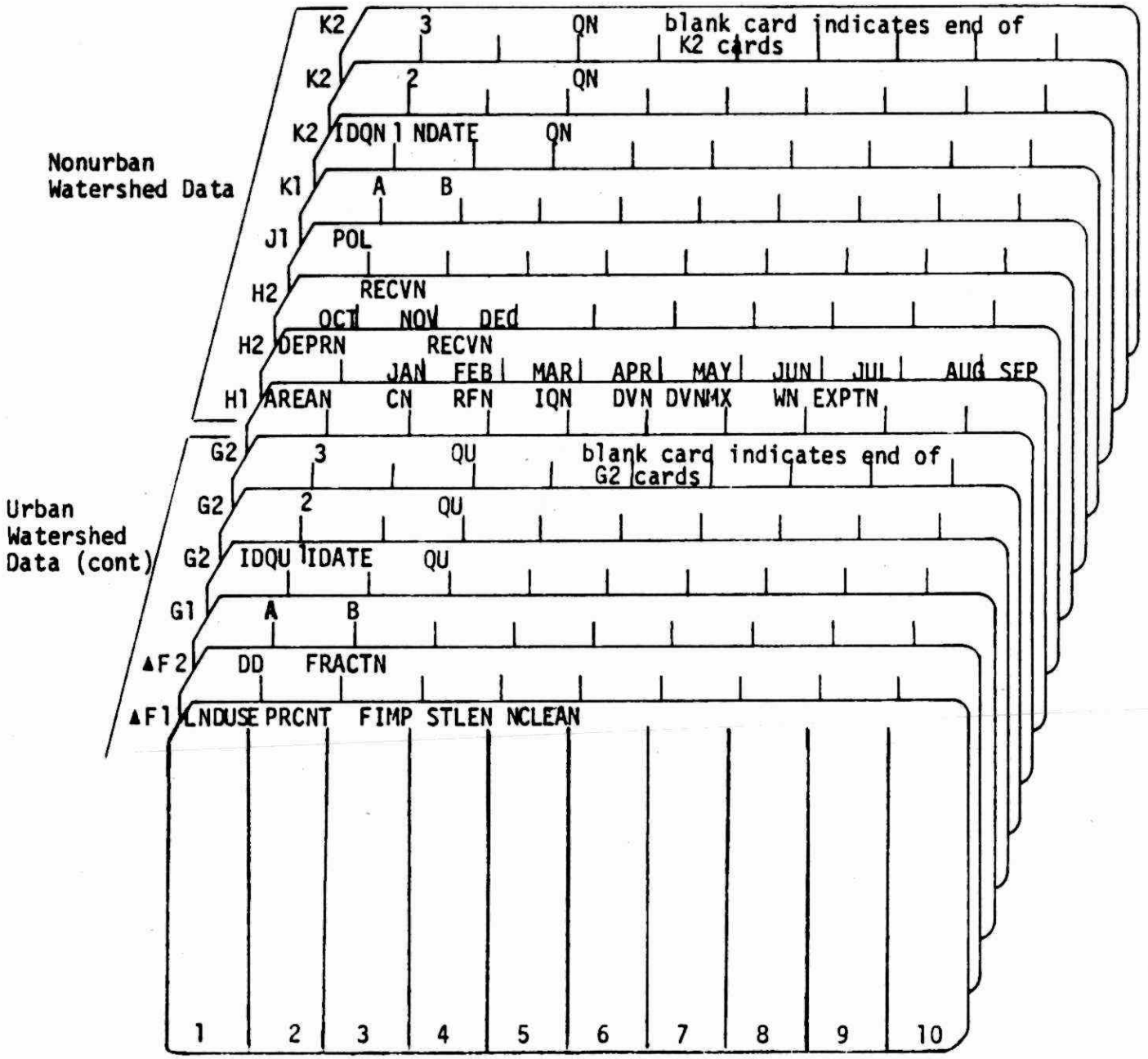
Land Use	Input Variable POL (J-1, 5)* Lbs. Pollutant/Day/Acre				
	Suspended	Settleable	BOD	N	PO_4
Open Space and Rural			.03	.007	.003
Agricultural (pastures)			3.1	.5	.35
Agricultural (farming)			.02	.23	.07
Forests (Douglas Fir)			.01	.002	.00002

*Values obtained from Cornell, Howland, Hayes and Merryfield, Seattle, WA. General data are not currently available for suspended and settleable solids; consult local water quality experts concerning these values.

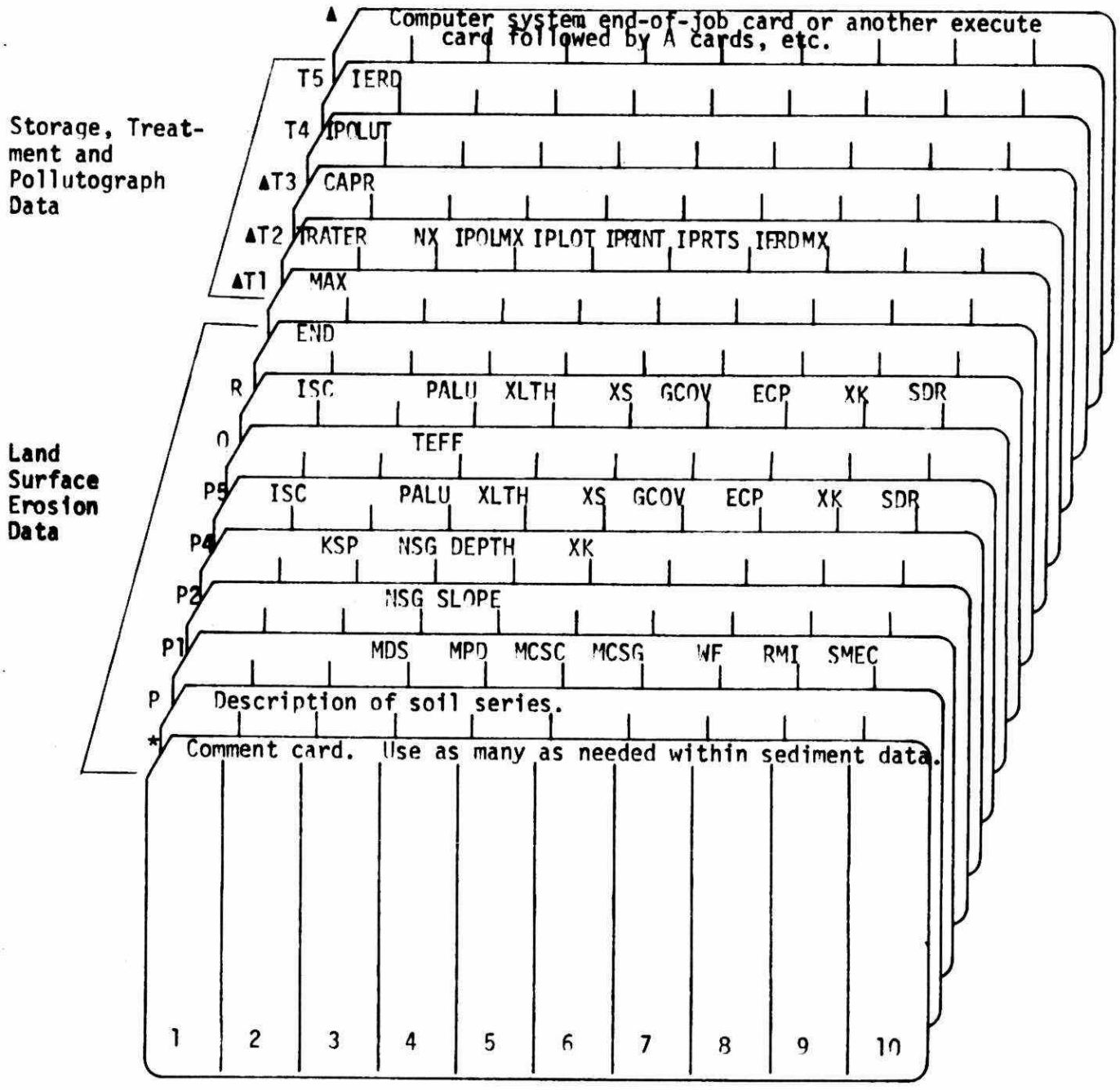
SUMMARY OF INPUT CARDS


Urban Watershed Data
Snow Data
Precipitation Data
Job Specifications
▲ E3 RECVRT
OCT NOV DEC
▲E3 DEPRS RECVRT
JAN FEB MAR APR MAY JUN JUL AUG SEP
▲ E2 AREA CPERV CIMP RFU IQU DVU DVUMX WU
▲ E1 NAMEWS MXLG EXPTE REFF
D2 JDATE,MAX,MIN,ITEMP in format 5X,I6,2I3,55X,I3
D1 ITAPE IFILE IFREZ IPACK ITMP COEF
C2 blank card indicates end of KRAIN data on cards.
C2 KDATE KRAIN in format 2X,I6,24I3
▲C1 NAME (col. 3-32) IN IFILE ISTART IEND IR
▲B2 NSUMR LEXT LINE LDATE LHR
▲B1 NWSHD ISNO NONURB ISED IQUAL IEVNT
▲A3 Title information for each page heading on this card.
▲A2 Title
▲A1 Title
1 2 3 4 5 6 7 8 9 10

▲ Required cards. Other cards are required depending upon input options.


Nonurban Watershed Data
K2 3 QN blank card indicates end of K2 cards
K2 2 QN
K2 IDQN NDATE QN
K1 A B
J1 POL
H2 RECVN
OCT NOV DEC
H2 DEPRN RECVN
JAN FEB MAR APR MAY JUN JUL AUG SEP
H1 AREAN CN RFN IQN DVN DVNMX WN EXPTN
Urban Watershed Data (cont)
G2 3 QU blank card indicates end of G2 cards
G2 2 QU
G2 IDQU IDATE QU
G1 A B
▲F2 DD FRACTN
▲F1 LNDUSE PRCNT FIMP STLEN NCLEAN
1 2 3 4 5 6 7 8 9 10

▲ Required cards. Other cards are required depending upon input options.


Storage, Treatment and Pollutograph Data
Land Surface Erosion Data
▲ Computer system end-of-job card or another execute card followed by A cards, etc.
T5 IERD
T4 IPOLUT
▲T3 CAPR
▲T2 IRATER NX IPOLMX IPLOT IPRINT IPRTS IERDMX
▲T1 MAX
END
R ISC PALU XLTH XS GCOV ECP XK SDR
0 TEFF
P5 ISC PALU XLTH XS GCOV ECP XK SDR
P4 KSP NSG DEPTH XK
P2 NSG SLOPE
P1 MDS MPD MCSC MCSG WF RMI SMEC
P Description of soil series.
* Comment card. Use as many as needed within sediment data.
1 2 3 4 5 6 7 8 9 10

▲ Required cards. Other cards are required depending upon input options.

APPENDIX E

BLANK TAPE ORDER SHEET

SWMM

DISTRIBUTED TAPE

VOLSER = _____

TRACK = 7/9

DENSITY = 200/556/800/1600/6250

LABELS = NL/SL

DCB = (RECFM = FB, LRECL = 80, BLKSIZE = 800)

FILE	DSNAME	DESCRIPTION
1	MAIN	SWMM MAIN BLOCK
2	RUNOFF	SWMM RUNOFF BLOCK
3	TRANSPORT	SWMM TRANSPORT BLOCK
4	STORAGE	SWMM STORAGE BLOCK
5	RECEIVE	SWMM RECEIVING BLOCK
6	TESTDATA	SWMM TEST DATA BLOCK
7	AES1	DATA BANK PROCESSING PROGRAM 1
8	AES2	DATA BANK PROCESSING PROGRAM 2
9	RAIN	RAINFALL ANALYSIS PROGRAM
10	HYETO	SHORT INTERVAL RAIN DATA PROCESSING
11	LUMP	GENERALIZED WATER QUALITY MODEL
12	STORM	STORM
13	CORE	ASSEMBLER SUBROUTINE REQUIRED BY STORM

Tapes are available from: Water Resources, Branch, Ontario Ministry of the Environment, 135 St. Clair Ave. W., Toronto, Ontario M4V 1P5.

TD
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.S76
1977

Storm water management
model study : volume III,
user's manual /

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